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Current status of the waste-to-energy chain in the County of North Savo, Finland

Laura Malo, Lea Koponen and Ari Jääskeläinen

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1 Introduction

The aim of this report is to describe the current status of the waste-to-energy chain in the County of North Savo in Finland. The work presented is part of the project REMOWE - Regional Mobilizing of Sustainable Waste-to-Energy Production which is part-financed by the European Union (European Regional Development Fund) as one of the projects within the Baltic Sea Region Programme.

The overall objective of the REMOWE project is, on regional levels, to contribute to a decreased negative effect on the environment by reduction of carbon dioxide emission by creating a balance between energy consumption and sustainable use of renewable energy sources. Reduction of carbon dioxide emissions and use of renewable energy sources are broad areas and this project will focus on energy resources from waste and actions to facilitate implementation of energy efficient technology in the Baltic Sea region within the waste-to-energy area. The focus is to utilize waste from cities, farming and industry for energy purposes in an efficient way. The problem addressed by the project concerns how to facilitate the implementation of sustainable systems for waste-to-energy in the Baltic Sea region and specifically, in a first step, in the project partner regions.

The project partnership consists of the Mälardalen University, with the School of Sustainable Development of Society and Technology coordinating the project, and The County Administrative Board of Västmanland in Sweden, Savonia University of Applied Sciences, Center for Economic Development, Transport and the Environment for North Savo and University of Eastern Finland (UEF) in Finland, Marshal Office of Lower Silesia in Poland, Ostfalia University of Applied Sciences, Fachhochschule Braunschweig / Wolfenbüttel in Germany, Klaipeda University in Lithuania, and Estonian Regional and Local Development Agency (ERKAS) in Estonia.

First, partner regions will in parallel investigate the current status, the bottle-necks and the needs for development and innovation. Partnering regions will then jointly study possible future status and paths to get there, taking into consideration the basis of each region. Here, tailored innovation processes will be organized in five project regions. These innovation processes will result in action plans for supporting SME:s as well as recommendations for improving regulations and strategies in the regions. Possibilities to build a regional model of the waste-to-energy utilization will be piloted in the project, with North Savo in Finland as a target region. This model could be a decision-support system for policy-making and investments.

The project activities are divided into 5 work packages. Work Package 1 concerns project management and Work Package 2 contains the project communication and information activities. In Work Package 3 the current status of the partner regions are explored, in Work Package 4 the possible future status is investigated and in Work Package 5 modelling of a sustainable regional waste-to-energy production will be studied.

The work presented in this report is part of the work in Work Package 3. The aim of this Work Package is to investigate the current status in the whole chain of waste- to-energy utilization in each partner region. The results from this work package are important background information for the activities in Work Package 4 and 5. The first step in development of action plans and strategies is to investigate the current conditions and systems from which the development has to start. By describing the current status in the different partner regions it will also be possible to learn from each other and find best practices that can be transferred to other regions. The aim is also to gather basic information needed for modelling of possible future systems and their environmental and human health impacts in work package 4 and 5. Data will be gathered concerning:

- Waste generation in farming, cities, industry
- Energy use and infrastructure
- Organic wastes composition and properties
- Biogas potential of different waste substrates
- Existing systems and technology used for sorting, utilization and use of residues for/in waste-to-energy

systems including economic profitability and system performance
- Relevant governing rules, legislation, regional interpretations and current development ideas
- SME:s interests in the waste-to-energy area and current development ideas
- Regional current situation in waste advisory services

The current status in the different partner regions will then be compared and best practices that can be transferred to other regions will be identified. This will be done by a workshop with all partners.

In this report the gathered data about the administrative structure and legislation, the waste management system including sources, amount and infrastructure of/for waste, the energy system including energy use, supply and infrastructure, and actors and stakeholders in the waste-to-energy area including interest and development ideas in one of the project partner regions, the County of North Savo in Finland, are presented.

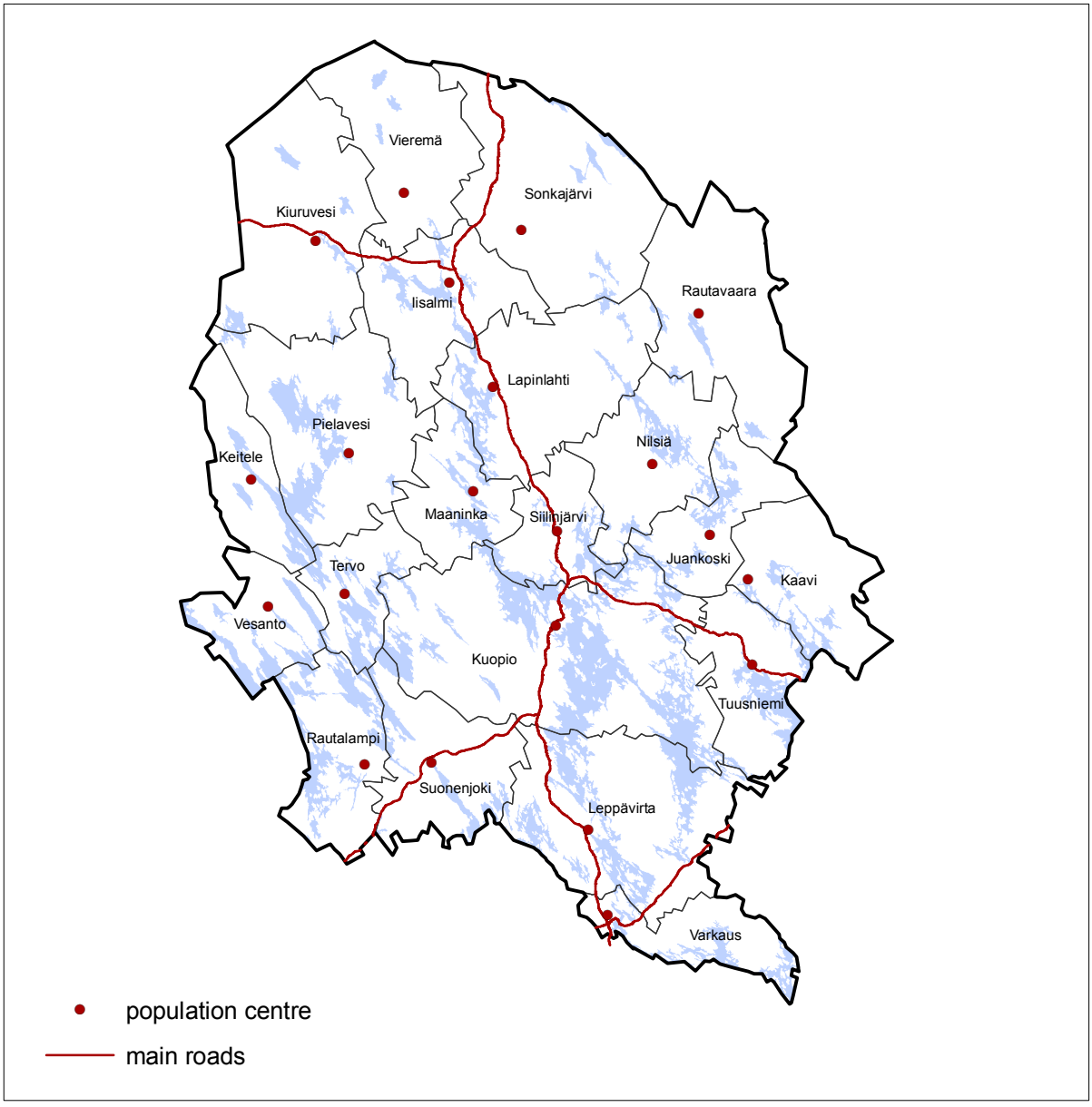
We define the current status as the reported figures valid for the years 2006 - 2009. In Finland the waste code system changed in the year 2005 and because of that waste data is not collected from years before 2006. The description of the current status consists of figures and descriptions of systems, technologies used, infrastructure, rules and regulations. The information for these descriptions is taken from VAHTI-database, written sources published during recent years and personal contacts with persons involved in the related activities.

This report has been primarily written by the Center for Economic Development, Transport and the Environment for North Savo, with help from Savonia University of Applied Sciences and University of Eastern Finland (UEF) in Finland. Data has been received from regional waste management companies Jätekukko Oy, Ylä-Savon Jätehuolto Oy and Keski-Savon Jätehuolto as well as energy companies Kuopion Energia Oy and Savon Voima Oyj.

2 Characteristics of North Savo region

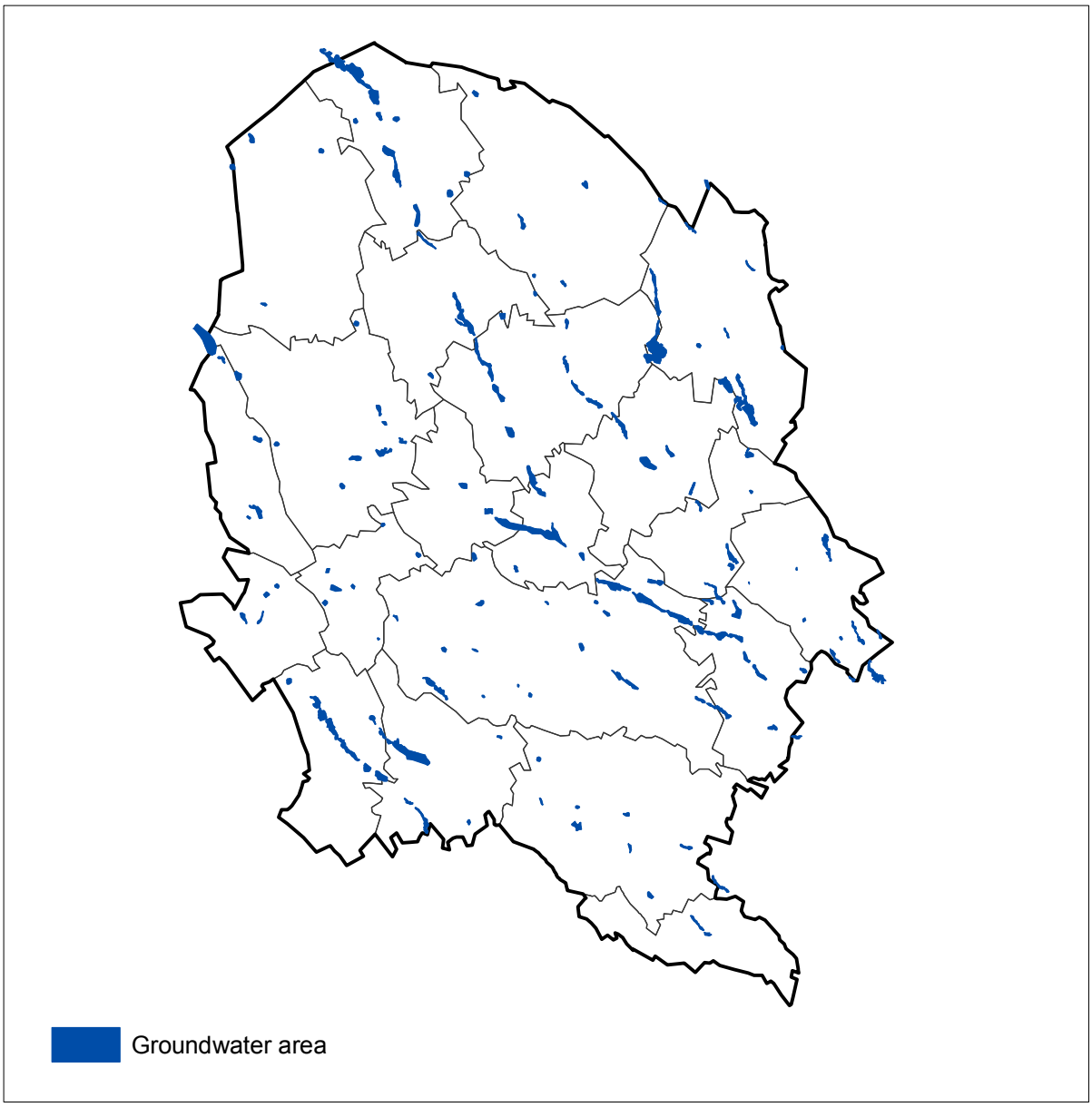
2.1 Geographic and climatic conditions

North Savo is a province of Eastern Finland and it is part of the most beautiful Finnish Lakeland. North Savo includes 21 municipalities from which seven are cities (Picture 1). The biggest cities of the province are Kuopio, Iisalmi and Varkaus. Kuopio is a lively and active university town, located in the rich scenery of lakeland. Varkaus is an international industrial town while Iisalmi is a provincial town with a rich cultural life. (The Regional Council of North Savo, 2011)



Picture 1. Map of North Savo region and its sub-regions.

There are 173 groundwater areas in North Savo (Picture 2). Groundwater areas are scattered irregularly on the area and are placed on the north-west-south-east-way esker formations.



Picture 2. Groundwater areas in North Savo

Weather types can change quite rapidly particularly in winter. The systems known to affect Finnish weather are the low-pressure system usually found near Iceland and the high-pressure systems in Siberia and the Azores. The position and strength of these systems vary, and each of them can dominate the weather for a considerable time. (Finnish Meteorological Institute, 2010)

According to the Köppen's climate classification, Finland belongs wholly to the temperate coniferous-mixed forest zone with cold, wet winters. The mean temperature of the warmest month is no lower than 10°C and that of the coldest month no higher than -3°C. Rainfall is moderate in all seasons. (Finnish Meteorological Institute, 2010)

2.2 Population

North Savo is the fifth largest and sixth most populated region in Finland. There live approximately 251 000 inhabitants in the region, which represents 5 % of the total population of Finland. The area of North Savo is 20 367 km2 and the population density in the area is about 12 inhabitants per square kilometer. 68 % of the workforce is employed in the service sector, 24 % in industry and construction and 10 % in agriculture and forestry. (The Regional Council of North Savo, 2011)

The regional structure of North Savo is the following (the year 2005): 230 km2 population center, 420 km2 village area and 11 350 km2 sparsely populated rural area. Rest of the area is water system area and uninhabited area. Water systems cover about 18 % of North Savo's area. (Pohjois-Savon liitto, 2010a)

The growth of population in North Savo has been slightly negative within the past 15 years. The reasons behind this are (Pohjois-Savon liitto, 2010a):

- the negative growth
- negative net migration
- higher mortality rate than birthrate
- the fast retirement rate of the baby boomers

However, there is a noticeable positive trend inside the number of population; the negative net migration has decreased and there are positive net migrations in some age groups. (Pohjois-Savon liitto, 2010a)

The constant negative net migration and the fast retirement rate of the baby boomers are rapidly changing the demographic and employment structure of the region and, at the same time, weakening the welfare potential of its residents. (Pohjois-Savon liitto, 2010a) The population age structure can be seen from Table 1 and the population forecast until 2040 inTable 2 Table 2 .

Table 1. The age structure of the population in North Savo region in 2007. (Pohjois-Savon liitto, 2010a)

Population amount	**Age 0 - 14**	**Age 15 - 29**	**Age 30 - 64**	**Age 65 -**
248 872	16,0 %	18,0 %	47,4 %	18,6 %

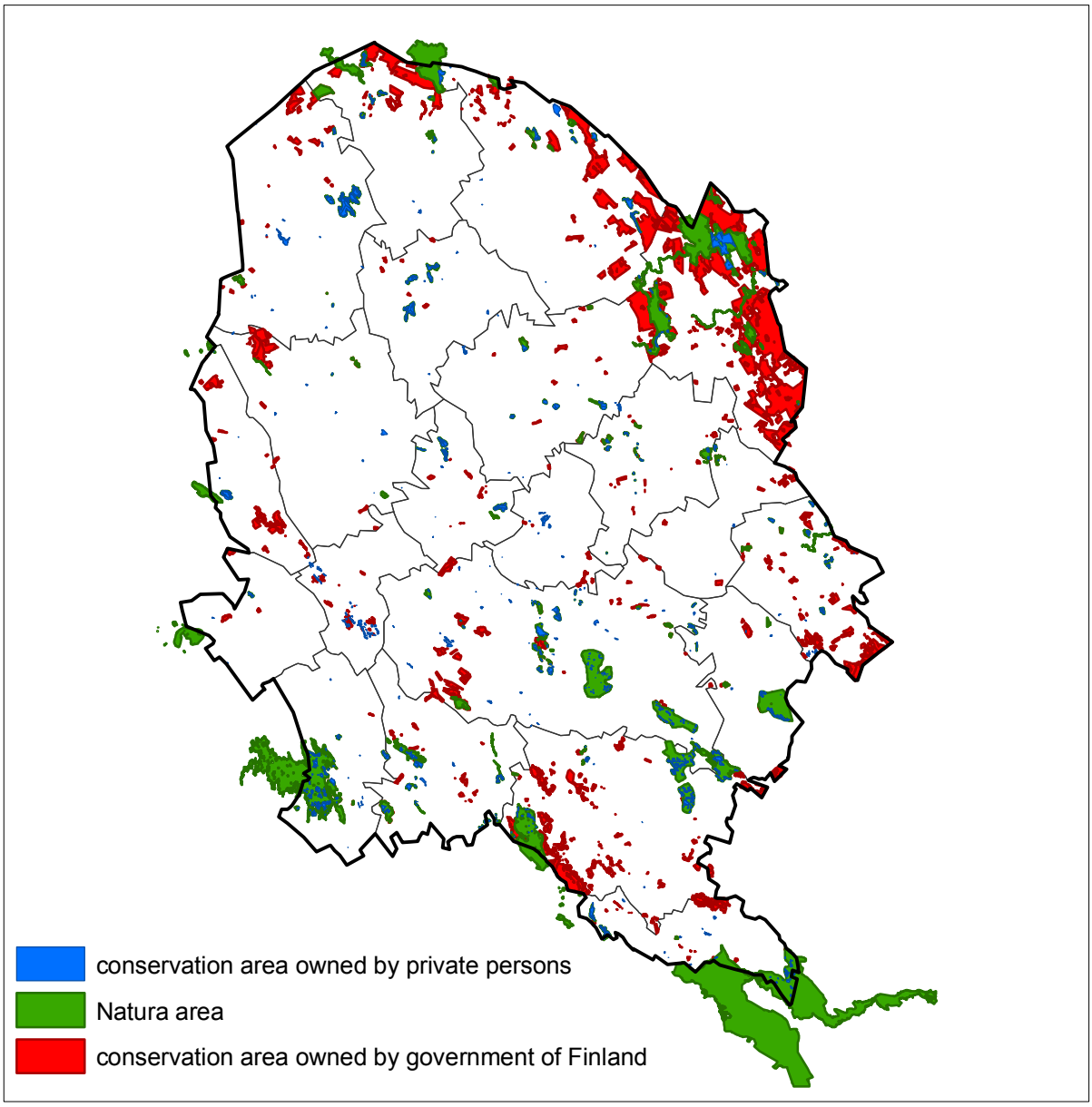
Table 2. Population forecast in North Savo and in the municipalities of North Savo until the year 2040. (Statistics Finland, 2004; Population register center 2011)

Year	2010	2020	2030	2040
Total population	234 839	237 593	229 465	218 008
Municipalities				
Iisalmi	22 169	20 517	19 545	18 307
Juankoski	5 273	4 987	4 703	4 391
Kaavi	3 429	3 284	3 149	2 967
Karttula	3 509	Consolidated to Kuopio in 2011		
Keitele	2 563	2 425	2 291	2 134
Kiuruvesi	9 318	8 043	7 358	6 712
Kuopio	92 626	94 443	92 797	89 531
Lapinlahti	7 525	7 036	6 817	6 463
Leppävirta	10 633	10 388	10 027	9 529
Maaninka	3 870	3 586	3 474	3 315
Nilsiä	6 521	5 878	5 564	5 177
Pielavesi	5 147	4 560	4 209	3 850
Rautalampi	3 520	2 952	2 723	2 498
Rautavaara	1 918	1 691	1 515	1 362
Siilinjärvi	20 964	21 478	21 371	20 670
Sonkajärvi	4 694	4 297	4 029	3 702
Suonenjoki	7 611	9 402	8 838	8230
Tervo	1 744	1 748	1 670	1 565
Tuusniemi	2 864	2 798	2 715	2 567
Varkaus	22 058	21 032	20 089	18 925
Varpaisjärvi	2 952	Consolidated to Lapinlahti in 2011		
Vesanto	2 412	2 104	1 918	1 754
Vieremä	3 985	3 462	3 229	2 997

As it is seen in the Table 2, the population of North Savo region continues to have a negative growth in the future and especially population of the small municipalities will decrease more quickly compared to bigger ones. Table 2 is based on population forecast made in the year 2004. Forecasts for the years 2020, 2030 and 2040 are from that forecast, but population information of the year 2010 is real. The forecast has turned out to be too optimistic and actually the population's negative growth level has been higher. There for the probability of forecasts for the years 2020, 2030 and 2040 are probably also too optimistic and population in North Savo region will go down even more quickly.

2.3 Protected areas

The protected land area in North Savo is approximately 32 000 hectares (Picture 3). The area consists mainly of old growth forests, herb-rich forests and different kind of bogs. The protected areas are either private property or owned by the state. Most of the protected areas belong to the Natura 2000-network. (Anne Grönlund, 2011)



Picture 3. Protected land area in North Savo.

2.4 Present status and future development of economy

Agriculture and the forest industry are the mainstays of the region, along with the metal industry. Their share of the export income of the entire country is significant. Tourism, farming and food and chemical industries also rely on natural resources. New areas of growth tend to be independent of the raw material supply, such as information technology, pharmaceutical development, agrobiotechnology, health and environmental technologies. (The Regional Council of North Savo, 2011)

The GDP (gross domestic product) of North Savo is a fifth lower than the GDP of the whole Finland. Between the years 2001 and 2007 the GDP of the county of North Savo has been on average level compared to the other counties in Finland. In the year 2008 GDP of North Savo was 7 119 million Euros. (Pohjois-Savon liitto, 2010b; The Regional Council of North Savo, 2011)

The biggest employer in North Savo is the service sector that gives work for 68 % of work force. 24 % of workforce works in industry and the rest 8 % in agriculture. (The Regional Council of North Savo, 2011) An upward trend of employment in the beginning of the 21th century changed in the year 2009 because of the economic recession of the world. In the year 2008 the unemployment rate of the county was 9,7 % and in the year 2009 it grew to 12,4 % (Pohjois-Savon liitto, 2011). The unemployment rate of the county was 10,0 % in the year 2010 when the unemployment rate of the whole country was 8,4 % (Tilastokeskus, 2011).

There operate about 9 800 companies in North Savo. 55 % of companies operate in service sector, 19 % in trade, 14 % in construction and 10 % in industry. The number of companies commensurate with population (20 inhabitants per company) in North Savo is lower than on average in Finland (16 inhabitants per company). (Savon yrittäjät, 2011; Pohjois-Savon liitto, 2010b)

The County Programme of North Savo has several targets for the future economic development. Those are:

- creating of biorefinery, energy technology and mechanical wood processing industry to the area
- improving the competitiveness of technology industry by increasing productivity
- strengthening of medicinal cluster
- profiling of innovation environments

3 Waste management administrative structure and waste legislation

3.1 Administrative structure of the region

The administrative divisions of Finland are the municipalities. Finland's Regional Councils are statutory joint municipal authorities operating according to the principles of local self-government. The Councils operate as regional development and regional planning authorities and are there for the units in charge of regional planning and looking after regional interests. On the basis of municipal democracy they articulate common regional needs and work to promote the material and cultural well-being of their regions. (The Regional Council of North Savo, 2011)

Regional Councils have also other tasks besides the statutory responsibilities. The Councils act as centers of development for the regions. They also pursue the interests of the region, its municipalities, inhabitants and businesses and carry out research, planning and analyses. The Regional Council is also the organization for cooperation between the various influences within the region. (The Regional Council of North Savo, 2011)

3.1.1 Waste administrative authorities

The Ministry of the Environment supervises and controls the way Finnish waste legislation is put into practice. (Finland's environmental administration, 2011)

The Finnish Environment Institute is an expert organization which conducts research and training, publishes new ideas and methods, and monitors all the development related to waste issues, while also participating in drawing up new legislation and guidelines related to waste. The Institute also monitors international waste transfers. (Finland's environmental administration, 2011)

Regional Centers for economic development, transport and the environment guide, encourage and monitor the implementation of the Waste Act in their own regions. They also provide training and advice for firms and the public, and issue waste permits to larger firms and operations. (Finland's environmental administration, 2011)

The Regional State Administrative agencies foster regional parity by executing all legislative implementation, steering and supervision functions in the regions. The agencies strengthen implementation of basic rights and legal protection, access to basic public services, environmental protection, environmental sustainability, public safety and a safe and healthy living and working environment in the regions. The Regional State Administrative agency issues environmental permits for example for waste management. (Finland's environmental administration, 2011)

Local authorities (mainly municipalities) organize the collection, recovery and disposal of household refuse and other similar waste, and supervise waste management in general in their own area. They also set local regulations on waste management, ensure that advice on waste matters is freely available, and issue waste permits to smaller firms and operations. (Finland's environmental administration, 2011)

3.2 Spatial planning of regional development

The Regional Council of North Savo is a regional development authority responsible for the general development of the North Savo region. The Council defines the development goals and the ways to achieve them as well as

fosters the region's development. (Regional Council of North Savo, 2011)

The council works to benefit the region and its inhabitants. As an organization that brings together the member municipalities, the council is engaged in development, planning, research and protecting the interests of the region. (Regional Council of North Savo, 2011)

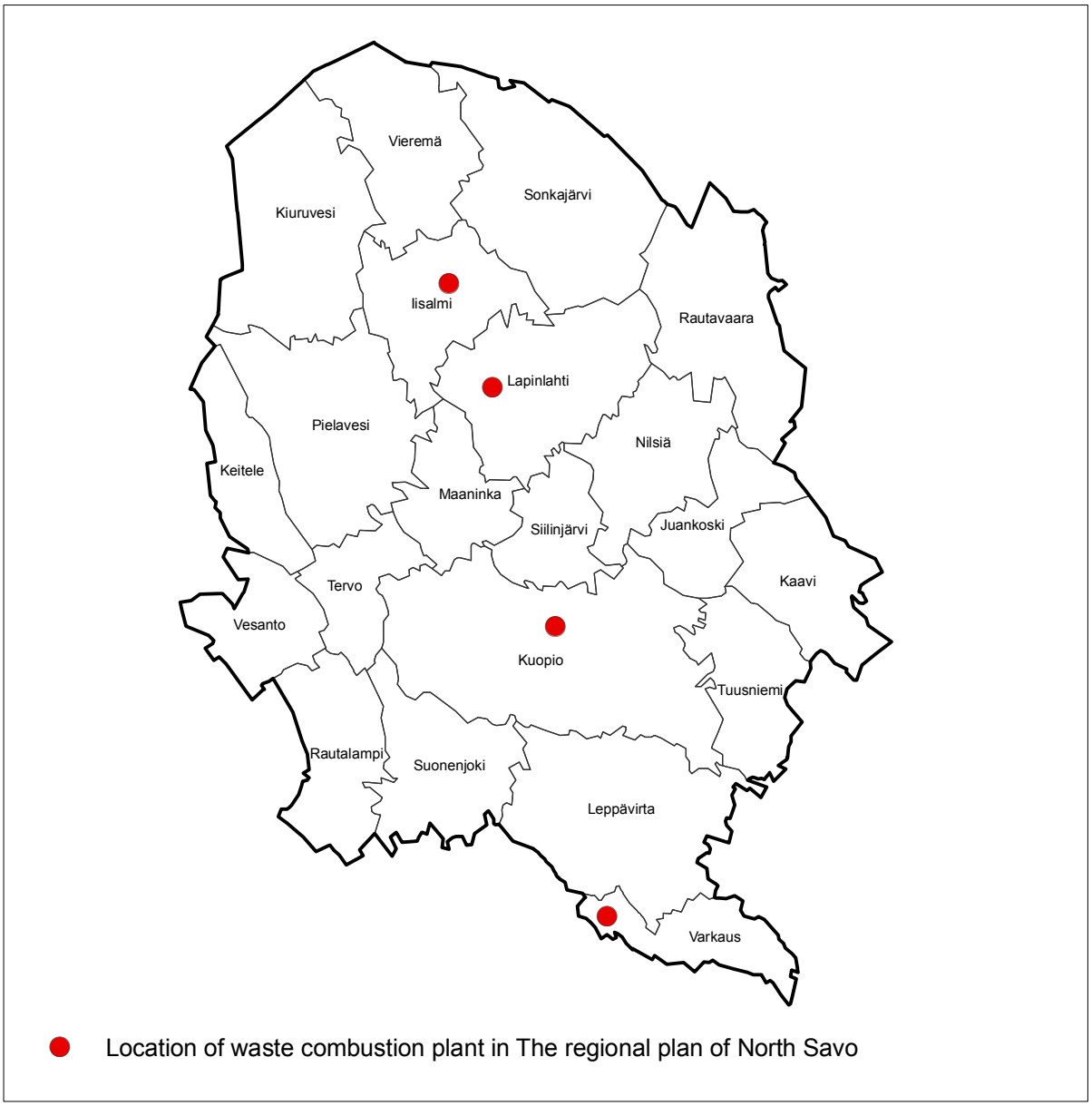
As the regional planning authority under the Finnish Land Use and Building Act, the Regional Council of Pohjois-Savo draws up the regional plan and supervises that the plan is implemented in structural, land-use and environmental planning of the municipalities in the region. (Regional Council of North Savo, 2011)

In Finland land use, spatial planning and construction are controlled by the Land Use and Building Act, which came into force in 2000. The Land Use and Building Act aims (Finland's environmental administration, 2011):

- to organise land use and construction to create the basis for high quality living environments,
- to promote sustainable development,
- to ensure open planning and participatory processes,
- to ensure that a wide range of planning expertise is available.

Regional plan

The Regional Council of North Savo accepted the new regional plan 2030 of North Savo in the end of the year 2010. The regional plan is currently on the table of the Ministry of Environment. The regional plan allows incineration of waste in Varkaus , Kuopio, Lapinlahti and Iisalmi (Picture 4). (Regional Council of North Savo, 2011)



Picture 4. Locations of waste combustion plants in the Regional Plan of North Savo

3.3 Governing rules and legislation of importance for waste-to-energy area

The target of the waste policy in Finland and EU is to improve sustainable use of natural resources and prevent the environmental and health hazards caused by waste.

3.3.1 EU directives

A new Waste framework directive (2008/98/EC) of EU was introduced in November 2008. This directive aims to prevention of waste generation, improve waste reuse and recycling and also to simplify the present waste regulations of EU. Reformation of Finnish waste law was adopted in March 2011. The Waste Framework directive guided the preparation work.

Packaging and packaging waste directive 94/62/EC requires that Member States should take measures to prevent the formation of packaging waste, and to develop packaging reuse systems reducing their impact on the environment.

Landfill directive 1999/31/EC aims to prevent or reduce as far as possible negative effects on the environment from the landfilling of waste, by introducing stringent technical requirements for waste and landfills.

Finland has drafted a national **biowaste strategy** in the year 2004 which particularly aims to reduce the amounts of biodegradable municipal waste ending up in landfill sites over the period 2006 - 2016. In 2006 the amounts of biodegradable wastes being disposed in landfills should correspond to less than 75 % of the 1994 level, while by 2016 the quantity should only amount to less than 35 % of the 1994 level. This means that only a maximum of 25 % of all the biodegradable waste expected to be generated in 2016 can go to landfill. Measures to reach this target include more recycling, the wider use of biological waste treatment methods such as composting, and the increased use of wastes in energy production. The strategy also aims to reduce emissions of methane. (Ympäristöministeriö, 2010)

Aim of the **Promotion of the use of energy from renewable source directive 2009/28/EC** is that Member States reduce their consumption of primary energy by 20 % by 2020. Finland's target is that 38 % share of renewable energy source of the final consumption of energy is reached by 2020. That Directive includes also the aim that is similar for all Member States: At least 10 % a share of renewable energy in final consumption of energy in transportation has to be reached by 2020. (Ympäristöministeriö, 2010)

Co-generation directive (2004/8/EC) aims at promoting the use of co-generation of heat and power (CHP).

3.3.2 Finnish waste legislation

Finnish waste legislation is largely based on EU legislation, but in some cases includes stricter standards and limits than those applied in the EU as a whole. Finland also has legislation on some issues related to wastes that have not yet been covered by EU legislation. Finland's waste legislation defines waste management activities in the following order of precedence (Finland's environmental administration, 2011):

- preventing wastes and reducing their harmful impacts
- recovering wastes - including primarily their material content and secondarily their energy content
- the safe treatment of wastes and the rehabilitation of any related damage

The Waste Directive 2006/12/EC is enforced in **the Waste Act (1072/1993)** and in the Waste degree (1993/1390). However reformation of the Finnish waste law is presently in course of preparation. The new waste law is purposed to come in to effect in the year 2011. The negative environmental impacts of wastes are also addressed in legislation on Environmental protection Act (86/2000) and Environmental Protection Decree (168/200). (Finland's environmental administration, 2011)

Taxes and fees payable in relation to wastes are generally included in legislation on taxation, although some fees are included in waste legislation. Other statutes covering specific economic activities also include certain controls related to wastes. (Finland's environmental administration, 2011)

Waste incineration ordinance 362/2003. In 3 § of the ordinance it is assumed that in case of waste incineration decrees and regulations of environment safety law 86/2000 and waste law 1072/1390 and what is said in environmental permission are obeyed. There is also supplementary decrees in Environment Protection Ordinance 169/2000 and in waste ordinance 1993/1390. The difference compared for example the Swedish

waste incineration ordinance is that for the waste incineration ordinance in Sweden is adapted to incineration of horse manure. (Ympäristöministeriö, 2010)

Regulation (EC) No 1069/2009 of the European Parliament and of the Council (Animal By-products Regulation) laying down health rules concerning animal by-products not intended for human consumption. The aim of the Animal By-products Regulation is to ensure a sufficient level of hygiene in order to prevent a spread of microbes causing disease and to ensure that the by-products are identifiable and traceable at all stages. Animal by-product regulation regulates for example animal products from biogas and composting plants that are included in category 2 and 3. Animal By-products Regulation requires that biogas or composting plants use animal by-products as raw material have a permission admitted by controlling authority (EVIRA in Finland). (Finland's environmental administration, 2011)

The use of fertilizer products in Finland is controlled by the Finnish Food Safety Authority (Evira). National **fertilizer legislation (539/2006)** ensures that all fertilizer products placed on the market in Finland are safe, of high quality, and suitable for plant production. This legislation also aims to promote the utilization of by-products suitable for use as fertilizers, provided that they have a proven positive impact on plant growth, and constitute no risk to humans, animals, plants or the environment. (Finland's environmental administration, 2011)

All fertilizer products imported or marketed in Finland must be included either in the national list of fertilizer type designations, or where EC fertilizers are concerned, in the list of fertilizer type designations specified in Annex I to EC Regulation 2003/2003. (Finland's environmental administration, 2011)

3.3.3 Waste regulation of municipalities

It is set in Finnish waste law that municipalities has an obligation to arrange waste management for household waste and waste alike household waste. Municipalities have to take care of waste transportation, arrangement of waste utilization and waste treatment. Most of the municipalities in Finland have given regional orders about how to arrange waste management in their area. These kinds of municipal waste treatment regulations can be given for example about waste collection, separation, storing, transportation, utilization or treatment as well as methods for prevention of environmental or health risks of waste treatment. (Finland's environmental administration, 2011)

3.3.4 Environmental permits of waste treatment companies

Environmental permits are needed in Finland for all activities that may lead to pollution of the air and water or contamination of the soil. Finnish waste law legislates that all waste treatment plants and professional waste treatment operation need an environmental permit. Authorities who can appropriate an environmental permit in Finland are the Regional Centers for Economic Development, Transport and the Environment and the Regional State Administrative agencies. The Regional State Administrative agency is the authority that appropriates most significant regional environmental permits and the Regional Centers for Economic Development, Transport and the Environment can appropriate the rest environmental permits. (Finland's environmental administration, 2011)

3.4 Waste policies and strategies

3.4.1 Aims of EU

Energy and climate strategy
The energy and climate strategy of EU was approved in the year 2008. The background of the strategy is a global

effort to decrease greenhouse gas emissions. The aim of strategy is to increase energy efficiency and renewable energy use and reduce greenhouse gas emissions. Quantitative targets to be met by 2020 of the strategy are:

- A reduction in EU greenhouse gas emissions of at least 20 % below 1990 levels
- 20 % of EU energy consumption to come from renewable resources
- A 20 % reduction in primary energy use compared with projected levels, to be achieved by improving energy efficiency. (Ulkoasiainministeriö, 2011)

Waste strategy - Making EU a recycling society

EU proposed the waste strategy in 2005. The waste strategy on prevention and recycling of waste aims to help Europe become a recycling society that seeks to avoid waste and uses waste as a resource. The actions proposed in the strategy was starting point for establishing the new Waste Framework Directive of EU and to for an obligation for Member States to develop national waste prevention programs.

3.4.2 National strategies

National waste plan until the year 2016

The Finnish Government approved in April 2008 the new national waste plan until the year 2016. The plan describes how waste management in Finland should look like in 2016 and how the goal will be achieved. The plan also contains a separate action plan for preventing the generation of waste. The national waste plan includes a separate national waste prevention programme. All centers for Economic Development, Transport and the Environment have each drafted their own regional waste plan. (Finland's environmental administration, 2011)

The goals of waste management are described by seven main themes (Finland's environmental administration, 2011):

- Improving the materials efficiency of production and consumption
- Promoting recycling
- Decreasing hazardous chemicals in waste
- Reducing harmful effects on the climate from waste management
- Reducing risks for health and the environment from waste management
- Developing and clarifying the organization of waste management
- Improving waste management know-how

The quantitative targets of National waste plan until the year 2016 are (Pohjois-Karjalan ympäristökeskus, 2009):

- the volume of municipal waste will be stabilized and then reduced to the level at the beginning of 2000 until the year 2016.
- 50 % of municipal solid waste will be recycled, energy will be recovered from 30 % and a maximum of 20 % will be disposed to landfills
- all manure from agriculture will be utilized, from which about 10 % will be exploited in biogas plants
- waste water sludge of sparsely populated area will be treated in waste water treatment plants and 10 % in biogas plants
- at least 70 % of construction waste will be utilized as material and energy
- 100 % of municipal sludge will be utilized as fertilizer of energy

Measures of promoting waste prevention by increasing materials efficiency are for example. (Finland's environmental administration, 2011):

- More effective legislation
- Eco-efficiency criteria in product standards, in eco-labels and in the tendering for public procurement
- Economic steering methods and possible subsidies
- Agreements about materials efficiency (for example in industry)

- Improved renovation and maintenance of buildings
- More strength to advice on waste prevention
- Expanding tax deductions to more repair services

Recycling will be increased so that the use of recycled materials in public civil engineering works will be increased and the use of applicable waste materials as fertilizer will be promoted. (Finland's environmental administration, 2011)

One aim is to reduce GHG emissions from wastes. To reach this aim about landfilling of biodegradable waste will be restricted and the recovery of methane gas from landfills will be strengthened. Also the energy recovery of those wastes which are not suitable for materials recycling will be increased. (Finland's environmental administration, 2011)

Biowaste strategy

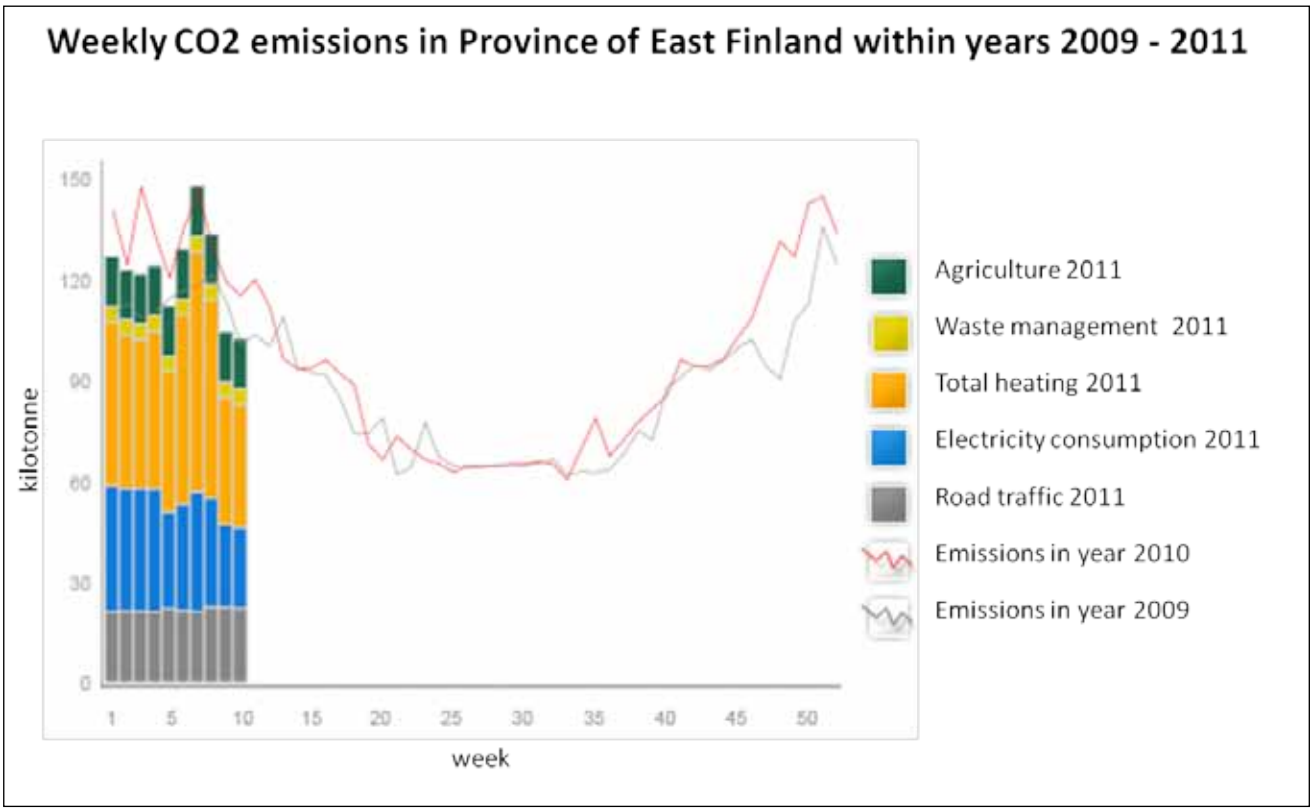
In 2004, Finland has drafted a national strategy to reduce the amounts of biodegradable waste going to landfill. The strategy also aims to reduce emissions of methane. The biowaste strategy particularly aims to reduce the amounts of biodegradable municipal waste ending up in landfill sites over the period 2006-2016. In 2006, the amounts of biodegradable wastes being disposed in landfills should correspond to less than 75 % of the 1994 level, while by 2016 the quantity should only amount to less than 35 % of the figure for the benchmark year. This means that only a maximum of 25 % of all the biodegradable waste expected to be generated in 2016 can go to landfill. (Finland's environmental administration, 2011)

Measures taken to help reach this target will include more recycling, the wider use of biological waste treatment methods such as composting, and the increased use of wastes in energy production. (Finland's environmental administration, 2011)

Climate and energy strategy

The Long-term Climate and Energy Strategy covers strategic energy objectives up to 2020 and also gives suggestions up to 2050. Measures to fulfil these objectives are increasing energy efficiency, energy saving and increasing renewable energy source on the final consumption of energy. Finland has an obligation that the share of renewable energy should increase to 38 % by 2020. Finland aims to cut greenhouse gases by 80 percent or more from 1990 levels by 2050. (Ympäristöministeriö, 2010)

In the Picture 5 there is presented carbondioxide emission from Eastern Finland.



Picture 5. Weekly CO2 emissions in Province of Eastern Finland within the years 2009 – 2011. (CO2-raportti, 2011)

3.4.3 Regional waste strategies

Waste plan for Eastern Finland

All Centers for Economic Development, Transport and the Environment have prepared their own regional waste plans in Finland. In addition, the three Centers in Eastern Finland (South Savo, North Savo and North Karelia) have jointly prepared the waste plan for Eastern Finland. The regional waste plan promotes realization of the national waste plan in regional level. Regional waste plans are not obligatory, but they have a directing effect for development of waste treatment. The aim of regional waste plans is to target practical activities to reach national or even stricter targets. Regional waste plan is a long term strategic development plan of waste treatment that covers the principles of prevention of waste generation, aims of waste treatment and focus of waste management. (Pohjois-Karjalan ympäristökeskus, 2009)

There are three main aims in waste plan of Eastern Finland (Pohjois-Karjalan ympäristökeskus, 2009):

1. decreasing the amount of waste
2. increasing the utilization level of waste
3. decreasing of environmental and health hazards (includes decreasing of green house gas emissions)

Decreasing the amount of waste is planned to do by improving material efficiency and by preventing waste generation. Measures for increasing the waste utilization level are improving waste collection systems of waste that is utilized as material or as energy and improving biowaste energy use. According to the national waste plan measures for decreasing environmental and health hazards of waste treatment are improving labour protection and usage of best available technique. Municipalities are responsible for organizing collection and treatment of waste water sludge in sparsely populated area. (Pohjois-Karjalan ympäristökeskus, 2009)

Waste strategies of waste management companies

There operate three waste management companies in North Savo area. Two of those have prepared waste strategies with their partner municipalities:

- Jätekukko Oy has established a waste strategy for the years 2005 -2009 in the year 2005. There also exists a draft version about waste political programme till the year 2015 of Jätekukko Oy partner municipalities.
- Ylä-Savon jätehuolto oy published a waste strategy in the year 2006

The main targets of Jätekukko Oy waste strategy are (Jätekukko Oy:n toimialueen kunnat, 2010):

1. Prevention of waste generation and promotion of products reuse
2. Effective utilization of waste
3. Improving of environmental responsibility in waste management
4. Sufficient standard of service in waste management and extensive service net
5. Target groups teaching, informing and advising
6. Clear role differentiation and working cooperation of waste treatment actors

Climate strategy for North Savo

Finnish Council of State has obliged that all biggest cities and provinces in Finland has to take part in realization of the Long-term Climate and Energy Strategy of Finland. Preparing work of climate strategy for North Savo has started in 2011. Strategic subject matters in climate and energy strategy are:

- community structure and traffic systems,
- energy management,
- forestry and agriculture,
- energy consumption of buildings,
- material and energy efficiency of production and consuming and
- new innovation and research and development activities. (The Regional Council of North Savo, 2011)

Climate strategy of city of Kuopio

In 1997, city of Kuopio made a survey about its greenhouse gas emissions and energy balance and was among the first cities in Finland to do so. Later in 2003, city of Kuopio prepared a climate strategy. (Ilmasto.org, 2011)

The latest climate strategy of Kuopio was published in 2009. It is called as the climate political programme of Kuopio for 2009 – 2020. Ambitions of the programme are (Kuopion kaupunki, 2009):

- By 2020, greenhouse gas emissions of city of Kuopio will decrease by 40 % from the level of 1990.
- Energy consumption of the activities of the city of Kuopio will decrease at the minimum of 9 % compared to the level of 2005.
- Greenhouse gas emissions from transportation and traffic will decrease. Bicycle and pedestrian traffic and public transport are attractive ways to move.
- Proportion of renewable energy in energy production is increased.
- Effects of the city of Kuopio's actions for climate change are noticed.
- The people in Kuopio are conscious of how their choices and actions effect energy consumption and green house gas emissions.

Bioenergy program of Eastern Finland 2020

Bioenergy program of Eastern Finland 2020 is a common program of five counties in Eastern Finland (South Karelia, South Savo, Kainuu, North Karelia and North Savo). The program contains practical actions to realize the climate and energy targets, including increasing of the production of biogas. (Pohjois-Karjala, Kainuu, Pohjois-Savo, Etelä-Savo ja Etelä-Karjala, 2011)

The target for the biogas production is to increase the production to 400 GWh per year. In the year 2008 the combined biogas production of North Karelia, North Savo and South Savo was 32 GWh. Produced gas is going to be used for heat and electricity production, and also for transportation. The use of biogas in the heat and electricity production is going to contribute by political actions. The biggest potential for biogas production in Eastern Finland is in farms, in communities´ waste water treatment plants and in the digestion of separately collected biowaste. The materials for biogas production are field biomass, sludge, manure, waste water sludge and landfill biogas. To reach the target, several dozen biogas plant investments must be done on the area. After the year 2015 biowaste disposal to landfill is not allowed in EU. This is also a baseline why it is needed to created new solutions and to increase the capacity for the biogas utilization. Regional councils can promote communities collaboration to start biogas production for transportation and to channel the funding for the investment projects of biogas production. (Pohjois-Karjala, Kainuu, Pohjois-Savo, Etelä-Savo ja Etelä-Karjala, 2011)

4 Waste management system and situation in North Savo region

In the partially reformed Finnish waste law (411/2007) has the responsibility of arrange of waste management distributed in three categories:

1. A municipal is responsible for household waste and waste which generates from public activity that has similar characteristic and generation amount than household waste. The responsibility does not concern hazardous waste.
2. Instructors of business activity are responsible for arrangement of waste management and of the waste generated by their own activities.
3. The producer responsibility obligates producers of certain products to arrange waste management for end of life products.

4.1 Waste management system

There exist different kinds of waste collecting systems in municipalities of North Savo, but in principle two different kinds of practices are used (Pohjois-Karjalan ympäristökeskus, 2009):

1. Municipality has arranged waste collection from properties.
2. Owner of property has a contract about waste collection with waste contractor.

There operate three municipal waste management companies in North Savo region: Ylä-Savon jätehuolto Oy, Jätekukko Oy and Keski-Savon Jätehuolto, which receive, handle and dispose municipal waste (Picture 6). The waste collecting area of Jätekukko Oy and Keski-Savon Jätehuolto also include municipalities outside of North Savo.

Picture 6. Waste management companies in North Savo. (Pohjois-Karjalan ympäristökeskus, 2009)

Jätekukko Oy

Jätekukko Oy a waste management company owned by municipalities operates in 18 municipalities. Five of those municipalities are outside of Norht Savo region. Jätekukko takes care of its owner municipalities legal waste management services. The company maintains a waste center (in Kuopio), which consist of landfill and handling of recyclable material. (Jätekukko Oy, 2011)

Inhabitant of a municipality in a population center and basic waste collection area of Jätekukko has to join waste transportation offered by Jätekukko. Properties collect waste to their own waste container or they have a shared waste container with other properties. Areas which are out of Jätekukko's waste transportation area have a possibility to join a local waste collection station maintained by Jätekukko. There exist 19 local waste collection stations in Jätekukko's operation area. Five waste collection stations locate in municipalities outside of North Savo. Jätekukko has also several eco points where inhabitants can leave typical household waste except mixed waste. Hazardous waste collection points of Jätekukko exist almost in every owner municipality of Jätekukko. (Jätekukko Oy, 2011)

Ylä-Savon Jätehuolto Oy
Ylä-Savon Jätehuolto Oy is a company owned by seven municipalities of Upper-Savo (Iisalmi, Kiuruvesi, Keitele, Lapinlahti, Pielavesi, Sonkajärvi and Vieremä), which include North Savo region. Ylä-Savon jätehuolto takes care of all waste management that waste law obligates municipalities to arrange. The company maintains a waste center, where they handle biowaste and recyclable materials and also dispose mixed waste to the landfill. Ylä-Savon jätehuolto does not arrange waste transportation, but every property has to make their own contract about waste transportation with local waste contractor. (Ylä-Savon jätehuolto Oy, 2011)

Keski-Savon Jätehuolto (former Varkauden seudun jätehuolto)
Keski-Savon Jätehuolto is a public utility owned by five municipalities (Heinävesi, Joroinen, Juva, Leppävirta and Varkaus). Heinävesi, Joroinen and Juva locate outside of North Savo region. The public utility takes care of municipal waste collecting and handling in its owner municipalities' area, maintains collection points of recyclable materials and hazardous waste and also arranges hazardous waste management in the area. Keski-Savon Jätehuolto has a hazardous waste and mixed waste landfill. Biowaste and waste water sludge is composted in Varkaus in a composting plant. Keski-Savon Jätehuolto has arranged waste collection in the region. That means that it has publicly procured their waste collection contractors. (Keski-Savon Jätehuolto, 2011)

4.2 Waste management infrastructure

According to the Waste law each property that is in use has to join organized waste transportation. Because of that every property has at least container for mixed waste, if the municipal waste management regulations does not require waste sorting. In that case property owner has a possibility to transport recyclable material to waste collecting stations. Some properties in sparsely populated area also take mixed waste to waste collecting stations. One possibility is also a shared mixed waste container with other properties. Collected mixed waste is transported with garbage truck directly or through waste loading places to waste management centers. (Pohjois-Karjalan ympäristökeskus, 2009)

Biowaste collection
Separate biowaste collection is based on residential building or produced biowaste amount. Waste treatment regulation of Ylä-Savon Jätehuolto Oy and Jätekukko Oy says that in the area of residential center minimum residential buildings of 10 households have to sort biowaste. In operation area of Keski-Savon jätehuolto sorting regulation relate minimum residential buildings of 9 households, which locate in residential center. Sorting regulation relates also to residential buildings in the area out of the residential center if biowaste production is more than 50 litres per week in the operation region of Ylä-Savon Jätehuolto, 30 kg per week in the operation region of Jätekukko Oy and 50 kg per week in the area of Keski-Savon jätehuolto. Biowaste is also possible to compost in above-mentioned residential buildings. Any of these three waste management companies do not obligate biowaste sorting if the residential building composts produce biowaste. Collected biowaste is transported to waste management plants for composting or digestion. (Ylä-Savon jätehuolto, 2011; Pohjois-Karjalan ympäristökeskus, 2009)

Jätekukko Oy has launched the separate collection of packed biowaste from supermarkets in the beginning of 2011 (Huttunen, 2011).

Recyclable waste
Small-sized properties carry out recyclable waste by themselves to recyclable waste collection stations. Like separate biowaste collection is recyclable waste collection based on residential building or produced waste amount. (Pohjois-Karjalan ympäristökeskus, 2009)

Jätekukko Oy collects carton, paperboard, metal and glass from minimum residential buildings of 10 households and if carton and paperboard waste production is over 30 kg per week and metal and glass production is over 50 kg per week. (Jätekukko Oy, 2011)

Only recyclable waste that Ylä-Savon jätehuolto collects is paperboard. Paperboard is collected when the production of paperboard is over 50 kg per week. (Ylä-Savon jätehuolto Oy, 2011)

Keski-Savon jätehuolto collects carton from minimum residential buildings of 9 households or when the carton waste production is over 20 kg per week. Paperboard is collected if the amount of paper board is one roller cage or 300 litres per two weeks. Metal is collected when it is produced over 50 kg per week. Metal is not collected from residential buildings. (Keski-Savon Jätehuolto, 2011)

Waste under the producer responsibility
In the Finnish Waste Law the following waste fractions belong to the producer responsibility:

- wastepaper
- clunkers and tires
- waste electrical and electronic equipment (WEEE)

Producers of waste under producer responsibility have to take care of extensive waste receiving and collection system. Municipal waste management regulations do not concern waste under producer responsibility except packaging waste, which is partly under producer responsibility. (Pohjois-Karjalan ympäristökeskus, 2009)

In the operation area of Keski-Savon Jätehuolto residential buildings of five households or more shall have a wastepaper collection container. In the operation areas of Jätekukko and Ylä-Savon jätehuolto waste management regulations of municipalities do not concern paper waste. (Pohjois-Karjalan ympäristökeskus, 2009)

Waste electrical and electronic equipment is collected by receiving network of WEEE. Clunkers and tyres are received mainly by private small entrepreneurs and national companies. (Pohjois-Karjalan ympäristökeskus, 2009)

Hazardous waste
Municipal waste management companies in North Savo region receive hazardous household waste. There are also some private hazardous waste collecting and receiving companies in the area. (Pohjois-Karjalan ympäristökeskus, 2009)

Construction waste
Waste management centers and also some private companies receive construction waste in North Savo. Those waste management centers are: waste center of Ylä-Savon jätehuolto in Iisalmi, waste station of Keitele in Keitele (cement and brick waste) waste center of Jätekukko Oy in Kuopio and Riikinneva waste center of Keski-Savon Jätehuolto in Leppävirta. In the operation area of Jätekukko Oy a small amount of construction waste is also possible take to municipal waste station of Jätekukko (except waste station of Maaninka). Some private companies in North Savo also receive cement and brick waste. (Pohjois-Karjalan ympäristökeskus, 2009)

4.2.1 Waste management centers and plants

Waste management centers and stations
There exist three waste management centers in North Savo: waste center of Kuopio owned by Jätekukko Oy, waste center of Peltomäki owned by Ylä-Savon jätehuolto and waste center of Riikinneva owned by Keski-Savon

Jätehuolto. Waste management centers receive, treat, store and dispose municipal waste.

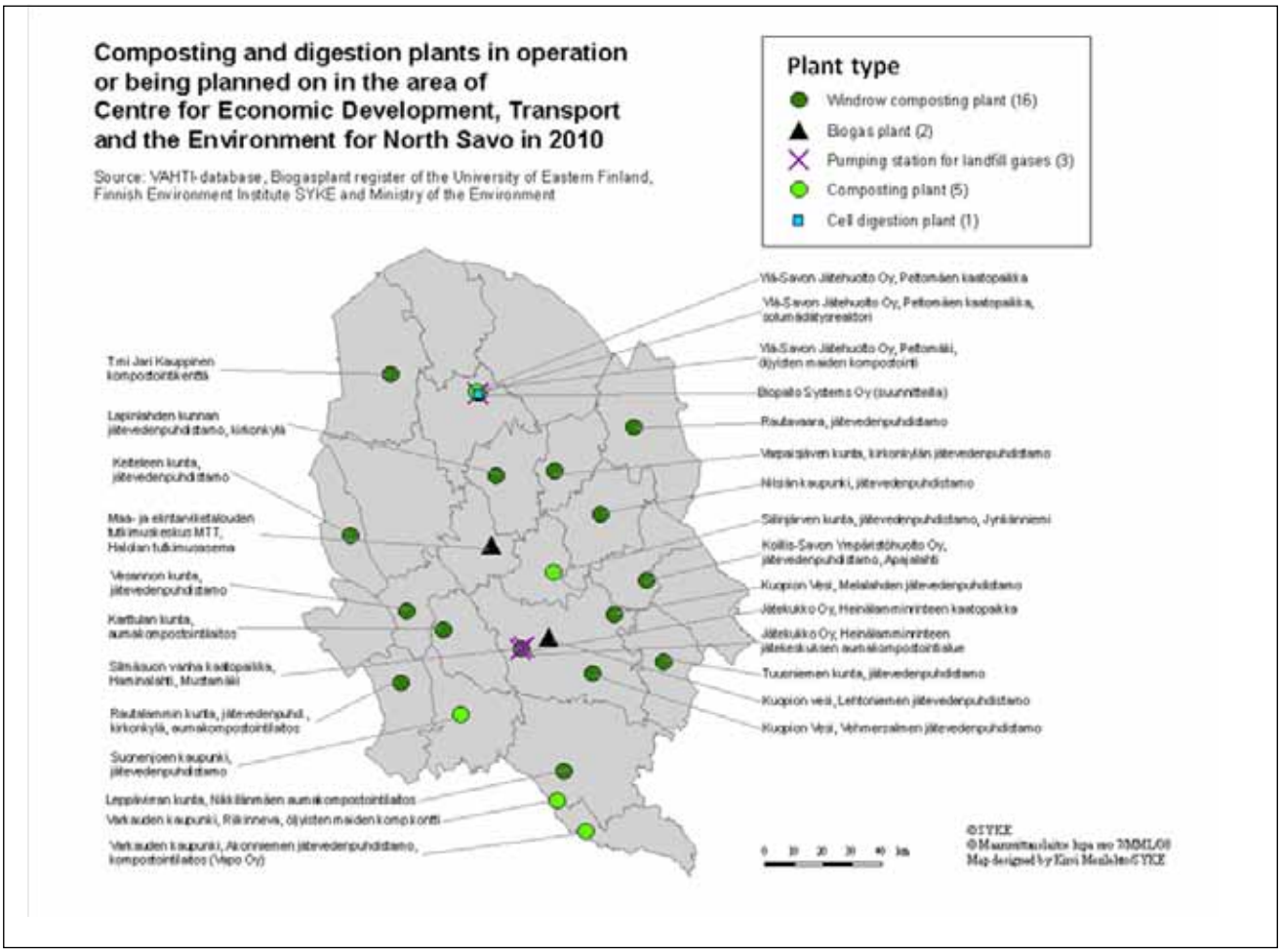
The amount of smaller waste receiving places, which are waste stations, is 17 in North Savo region. These waste stations locate in operation area of Jätekukko Oy, where in every municipal except Maaninka locates one waste station, and in the commune of Keitele, where waste station is maintained by a private entrepreneur. (Pohjois-Karjalan ympäristökeskus, 2009)

Composting plants

There locate five composting plants and 16 windrow composting plants in North Savo area (Picture 7). Composts are used for wastewater sludge, biowaste and plant waste composting. Furthermore, manure from a slaughterhouse is composted in the waste center of Kuopio.

One of the composting plants is a tunnel composter in Varkaus owned by Vapo Oy. That composter is used for wastewater treatment sludge and biowaste composting. The capacity of the compost is about 6000 tons of mix of biowaste and sludge per year (Lind, 2010). This moment yearly loading is about 4000 tons per year and electric consumption is about 20 000 kW per month (Lind, 2010). There locates also a composting plant of oily land in Varkaus.

There locate drum composting plants in Siilinjärvi wastewater treatment plant of Jynkänniemi and in Suonenjoki wastewater treatment plant. Both drum composting plants are used for wastewater sludge composting. Wastewater sludge is dewatered before composting. Dewatering in Suonenjoki is handled by sludge centrifuge. In Siilinjärvi sludge is also stabilized before composting. Average reaction time in the process of Siilinjärvi plant is seven days. In Suonenjoki peat and sawdust are used as a supportive material in composting. In Siilinjärvi A supportive material in composting is peat. (Itä-Suomen ympäristölupavirasto, 2003; Itä-Suomen ympäristölupavirasto, 2005).



Picture 7. Composting and digestion plants and biogas pumping stations of landfill gases in North Savo.

Biogas plants

There locates two biogas plants in North Savo area, one in Lehtoniemi wastewater treatment plant of Kuopion Vesi in Kuopio and the other one in Halola Maaninka in the research center of Agrifood Research Finland (MTT). The biogas plant of Kuopion Vesi (Picture 8) digests wastewater treatment sludge and the biogas plant of Agrifood Research Finland digests livestock manure.

The biogas plant of Kuopion Vesi has been built in the year 1987. The reaction capacity of plant is 2 x 3000 m3 (two reactors). The biogas plant handles about 7000–8000 tons of wastewater sludge (25 % dry matter content) per year. Waste water is dried by a centrifuge before digestion. All produced biowaste is used for electricity and heat production. An efficiency of electricity production is 330 kWh and an efficiency of heat production is 440 kWh. The manufacturer of biogas engine is Jenbacher. About 90 % of the wastewater treatment plant's energy demand is produced by biogas. (Kuittinen et al., 2007) In the year 2008 biogas in Lehtoniemi was produced 1,149 million m³ (Kuittinen et al., 2009).

The biogas plant of the research center of Agrifood Research Finland in Maaninka has been built in the year 2009. The reaction capacity of plant is 300 m3. The biogas plant produces biogas from cow manure and plants' biomass. After digestion residue is utilized as a fertilizer in fields. The biogas plant is automatic and it saves all measuring information of the biogas process. Temperature of reactor is possible to adjust between 20 – 55 °C. In initial stage of biogas plant experiments the reactor temperature is mesophilic (37 °C). (The research center of Agrifood Research Finland, 2009)

Picture 8. Biogas plant of Kuopion vesi. (Kuittinen et al., 2007)

Landfill with biogas capture

Landfill gas is collected from four landfills in North Savo. Two landfills (Heinälamminrinne and Silmäsuo) are in Kuopio, one in Iisalmi (Peltomäki) and one in Leppävirta (Riikinneva).

Landfill gas from landfill of Heinälamminrinne and Silmäsuo is burned in the local energy plant in Kuopio. Riikinneva and Silmasuo generate landfill gas about two million cubic meters per year (Ympäristöhallinto, 2011) biogas pumping stations capacity is 500 Nm3/h and potential fuel efficiency about 2,5 megawatts that correspondence to yearly heat demand of 800 detached houses in Finland (Kuittinen et al., 2009).

Landfill gas from Peltomäki landfill is burned in a torch, when the energy content of the gas is lost. However burning in a torch is better alternative than letting methane escape into the atmosphere. Biogas production in Peltomäki is about 870.000 cubic meters per year, which approximate energy content of about 350.000 litres oil (Ympäristöhallinto, 2011). The capacity of Peltomäki gas capture system is 300 Nm3/h (Kuittinen et al., 2009). Burned landfill gas includes also biogas that generates in digestion cells of biowaste. Risto Kauhanen managing director of Ylä-Savon Jätehuolto says that they have considered possibility to lead landfill gas to energy utilization and it is possible that in the future landfill gas is burned in a local energy plant.

Landfill gas from Riikinneva landfill is treated by oxidizing biofilter, when methane escape to atmosphere is prevented. Methane content of landfill gas is about 50 %. The generation amount of biogas is not known, but the lost energy content of biogas might approximate about 250.000 litres of oil. (Ympäristöhallinto, 2011).

Table 3. Biogas production of landfills within 2006-2009. (Kuittinen et al., 2007-2010)

Year	Landfill	Production (1000 m3)	Utilization (1000 m3)	Heat (MWh)	CH4 %
2009	Kuopio, Heinälamminrinne	1100	1100	5195	53
	Iisalmi, Peltomäki	800			45
	Kuopio, Silmäsuo	500	500	1960	44
2008	Kuopio, Heinälamminrinne	1200	1200	5560	52
	Kuopio, Silmäsuo	800	800	2851	
	Iisalmi, Peltomäki	800			45
2007	Kuopio, Heinälamminrinne	1190	1190	5620	53
	Kuopio, Silmäsuo	900	900	3208	40
	Iisalmi, Peltomäki	900			41
2006	Kuopio, Heinälamminrinne	1200	1200	5574	54
	Kuopio, Silmäsuo	1000	1000	3475	39
	Iisalmi, Peltomäki	500			38

Waste combustion plants

No waste combustion plant exists in North Savo. However, Lapinlahden Ekolampö Oy has a permission to combust 14 000 tons of thermally dried wastewater treatment sludge in its power plant in Lapinlahti. (Itä-Suomen ympäristölupavirasto, 2006)

The former Ecogas gasifier and boiler plant of Stora Enso Plc's pulp and paper integrate in Varkaus is nowadays owned by Varkauden Aluelämpö Oy. The Boiler Seven and the detached gasifier might be suitable for utilizing mixed municipal waste retentate (after crushing and screening) as well as pre-treated industrial waste for energy. However, this would demand renovation for the system.

Eight waste management companies in Eastern Finland have a project where they study a possibility to build eco power plants to Varkaus and Kitee. The power plant in Varkaus would be 60 MW plant and 40 MW plant in Kitee. Fuel of these plants would be wood and REF. Boiler technology of both combustion plants would be circulation fluidized bed boiler. Before combustion waste would be separated and crushed in a plant. The separation would sort out materials that are suitable for utilization, like metals. Rest of the material would crush and combust with wood in power plant.

In the study both eco plants have been found out to be technically and economically realistic. During the year 2011 waste management companies that are participating in this study will make a decision how to continue the project and which is the best location for the eco power plant. (Jätelaitosyhdistys, 2011)

Waste handling companies

There operate about 20 waste collection companies in North Savo region. The relevant waste handling companies have been listed in Table 4.

Table 4. Waste handling companies in North Savo. (Pohjois-Karjalan ympäristökeskus, 2009)

Waste treatment company and location	Waste type	Waste treatment method	Type of company
Lapinlahden Biolämpö Oy Lapinlahti	Wastewater sludge	Sludge combustion	Sludge treatment plant
Ecomurske Oy Iisalmi	Recycled fuel, waste wood	Waste sorting and crushing	Private waste treatment company
Ekokem Palvelu Oy Heinälamminrinne Kuopio	Hazardous waste, sludge, construction waste	Waste sorting and packing for continued handling, sludge drying	Private waste processing center
Ekokem Palvelu Oy Sorsasalo Kuopio	Industrial waste, ashes, contaminated soil, sludges	Waste sorting, crushing, stabilization, drying, composting	Private waste treatment center
Ekokem Palvelu Oy Iisalmi	Plastics from agriculture	Receiving, energy recovery (outside North Savo)	Private waste logistical center
Demolite Oy Several waste bins in North Savo	Separately collected impregnated wood	Receiving, energy recovery (outside North Savo)	Collection and energy utilization system of Finnish impregnated wood industry
Kiinteistöhuolto Rytkönen Oy Iisalmi	Paper, board, construction waste, packing metal, wood waste	Waste sorting and baling	Private waste treatment center
Matti Kuitunen Oy Varkaus	Paper, board, wood pallets, plastic packages	Waste receiving, sorting, packing and storing	Private waste treatment company
Paperinkeräys Oy Kuopio	Paper and plastic packages	Waste recovery, baling	Group's parent company, wholesaler, producer association
Savon Siemen Oy Iisalmi	Grease	Biodiesel manufacturing	Industrial processing of waste

4.3 Sources of waste

Municipalities, industry and trade as well as agriculture produce waste that can be used for energy in North Savo. Especially agriculture produces lots of waste that is suitable for biogas production.

4.3.1 Separately collected municipal waste

Municipal waste is household waste and waste from industry, service or other kind activities that is similar with household waste. Characteristic for all municipal waste is that it is generated from final products consuming and it is handled by municipal waste management.

Mixed municipal waste

In the year 2009 three waste management companies received about 87 000 tons of mixed municipal waste in North Savo (Table 5). Mixed municipal waste amount includes both mixed waste from households and industry. The reason for this is varying reporting practices, sometimes mixed waste of industry is included in mixed waste of municipal and sometimes they are reported separately. In the year 2008 the amount of received mixed municipal waste was about 5 400 tons higher than in the year 2009. Lower mixed waste amount in the year 2009 can probably be explained by downswing of world economy. From the year 2006 till the year 2008 the amount of mixed municipal waste has grown yearly. Within the years 2007 – 2009 the city of Varkaus received mixed municipal waste outside of North Savo. That waste is not included in mixed municipal waste amounts in Table 5. (VAHTI, 2011)

The main disposal method of mixed waste in North Savo is landfill. Actually it has been the only disposal method until the 2009, when 7 % of mixed waste was used as recycled fuel (VAHTI, 2011). On that year Jätekukko Oy started experiment of crushing and screening of mixed waste (Jätekukko Oy, 2009). Crushing machine crushes mixed waste and a drum screen separates the waste into smaller particles (biowaste, sand, glass etc.) and bigger particles (plastic, paper, paperboard etc).

The main source of mixed waste amounts has been in VAHTI-database. It is challenging to get reliable information about mixed waste amounts and quality, because of different kind of reporting practices.
According to a study made by Jätekukko Oy, on average 20 % of mixed municipal waste is food biowaste and about 7 % is garden waste. (Jätekukko Oy, 2009)

Table 5. Mixed municipal waste amounts (VAHTI, 2011).

Mixed waste, EWC 200301				
Year **Waste management company**	**2006** **(t)**	**2007** **(t)**	**2008** **(t)**	**2009** **(t)**
Jätekukko Oy	48331	48039	55525	50819
City of Varkaus	16903	19145	19410	20234
Ylä-Savon jätehuolto Oy	16409	17111	17445	15918
Total amount	**81643**	**84295**	**92380**	**86971**

Biodegradable kitchen and canteen waste

All three communal waste management companies in North Savo collect separate biowaste that consists of biodegradable kitchen and canteen waste. The amount of separately collected biowaste has grown within the years 2006 – 2009, except the year 2008 when the amount of biowaste was same as in the year 2007 (Table 6).

Table 6. Amounts of biodegradable kitchen and canteen waste (VAHTI, 2011).

Biowaste, EWC 200108					
Year **Waste management company**	**2006** **(t)**	**2007** **(t)**	**2008** **(t)**	**2009** **(t)**	**Solid** **Matter (%)**
City of Varkaus	1130	1130	943	852	55
Ylä-Savon jätehuolto Oy	855	917	991	933	
Jätekukko Oy	4114	4452	4565	5598	50
Jätekukko Oy, Eastern area			1284	878	50
Total amount	**6099**	**6499**	**6499**	**7383**	

The main disposal method for collected biodegradable kitchen and canteen waste is composting. Biowaste collected by City of Varkaus is composted in a reactor composter together with sludge from wastewater treatment plant of Varkaus. Ylä-Savon jätehuolto Oy digests separately collected biowaste in digestion cells. Jätekukko Oy takes all biowaste to windrow composting to Outokumpu, outside of North Savo. The distance between Kuopio and the windrow composting place in Outokumpu is about 90 kilometres by road.

Edible oil and fat

Separately collected edible oil and fat waste amounts are shown in the Table 18. Edible oil and fat waste of municipal is mainly digested in the local waste water treatment plant and the rest of that waste is used for material utilization like biodiesel manufacturing. (VAHTI, 2011)

Table 7. Amount of edible oil and fat (VAHTI, 2011).

Edible oil and fat, EWC 200125				
	Year 2006 (t)	**Year 2007 (t)**	**Year 2008 (t)**	**Year 2009 (t)**
Edible oil and fat	918	1216	1193	1372

Biodegradable waste

Biodegradable waste of municipality consists mainly of gardening waste (Table 8). In the year 2009 about 53 % of biodegradable waste was composted, 36 % was used for energy utilization and rest was disposed to landfill. (VAHTI, 2011)

Table 8. Biodegradable waste (VAHTI, 2011).

Biodegradable waste, EWC 200201				
	Year 2006 (t)	**Year 2007 (t)**	**Year 2008 (t)**	**Year 2009 (t)**
Biodegradable waste	2634	2503	2776	2900

Paper and paperboard waste

In 2009 the amount of separately collected paper waste was about 12.000 tons, which is substantially less than in the years 2006–2007 (Table 9).

All separately collected paper and paperboard waste is mainly used for material utilization. Dirty and other paper and board waste that is ineligible for material utilization (under 1 % of paper and board waste) is taken to landfill or burned. (VAHTI, 2011)

Table 9. Amounts of board and paper waste (VAHTI, 2011).

Board and paper, EWC 200108				
	Year 2006 (t)	**Year 2007 (t)**	**Year 2008 (t)**	**Year 2009 (t)**
Board and paper	18179	16301	15801	12332

Packaging waste (EWC-codes 150101, 150102, 150103 and 150106)

Packaging waste amounts informed in VAHTI database are not very reliable (Table 10). The reason for that is a difficulty to define which waste is packaging waste and which for example is normal paper and board waste. Because of this it is probably that part of packaging waste is not reported as packaging waste and vice versa. Collected packaging waste amounts have mainly increased from the year 2006 till the year 2008. Instead of that waste amounts have decreased outstandingly in the year 2009 compared to the year 2008. (VAHTI, 2011)

Table 10. Amounts of packaging waste (VAHTI, 2011).

Packaging waste					
	EWC-code	**Year 2006 (t)**	**Year 2007 (t)**	**Year 2008 (t)**	**Year 2009 (t)**
Paper and board packaging	150101	7337	7448	11943	7187
Plastic packaging	150102	465	1329	1952	2834
Wooden packaging	150103	733	922	576	609
Mixed packaging	150106	806	1339	1492	948
Total amount		**9341**	**11038**	**15963**	**11578**

Wood waste (EWC-code 200138)

Municipal wood waste amounts within the years 2006 – 2009 are shown in Table 11. This waste is mainly used for energy utilization, but for example in the year 2009 16 % of municipal wood waste went to landfill and rest of wood was burned. (VAHTI, 2011)

Table 11. Amounts of wood waste (VAHTI, 2011).

Wood waste, EWC-code 200138				
	Year 2006 (t)	**Year 2007 (t)**	**Year 2008 (t)**	**Year 2009 (t)**
Wood waste	3050	3337	4206	3925

4.3.2 Waste from municipal wastewater treatment plants

Over 85 % of municipal wastewater of North Savo is treated in biologic-chemical wastewater treatment plant (Pohjois-Savon Elinkeino- liikenne- ja ympäristökeskus, 2010). There locates 38 wastewater treatment plants in North Savo that have an environmental permission. Three of those are wastewater treatment plants of industry and the rest are municipal plants which treat both industry and household wastewater or only household wastewater. Several wastewater treatment plants in North Savo receive septic tank and cesspit sludge and some plants also receive wastewater sludge from small wastewater treatment plants. Waste from municipal wastewater treatment plants is waste from screens and sieves, sand and sludge. Oil and grease waste of industry are separated from wastewater before municipal wastewater treatment plants. (VAHTI, 2011)

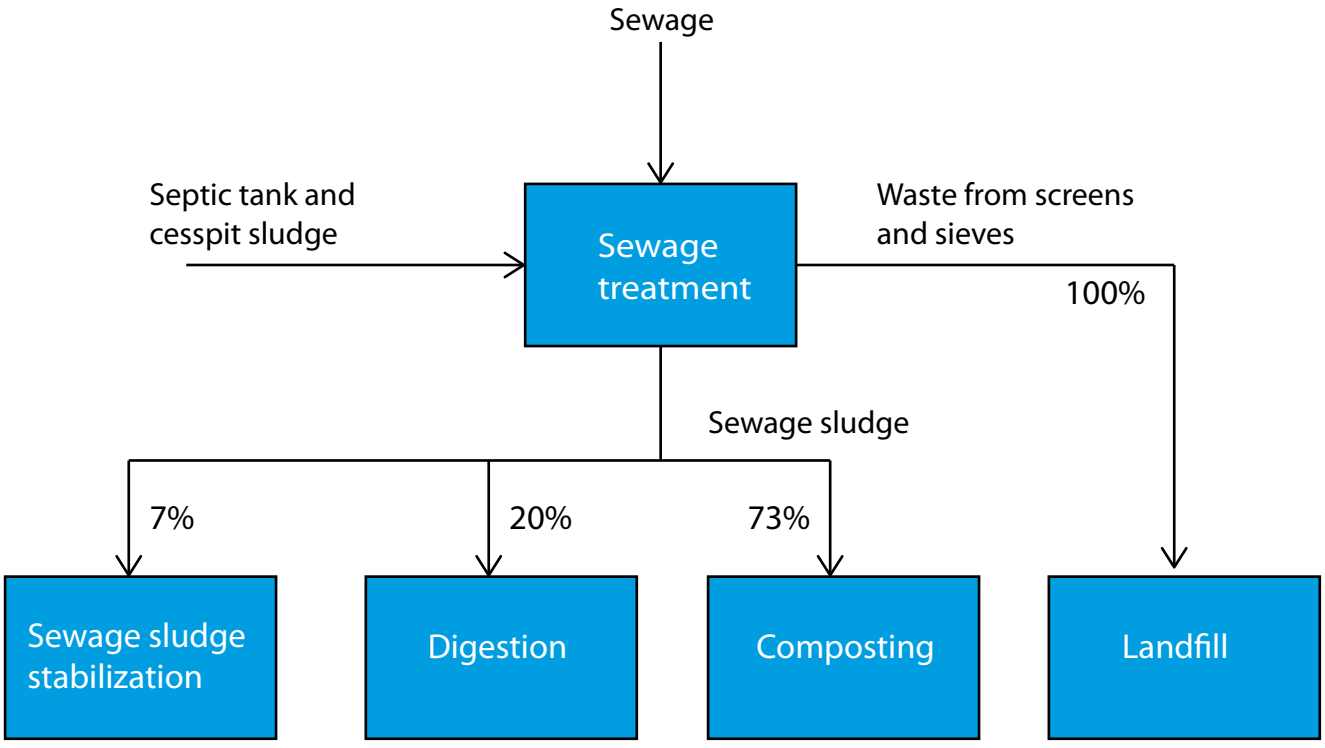
In the year 2009 wastewater treatment plants produced about 1300 tons of waste from screens and sieves and about 47 700 tons of sludge waste (dry mass varies from 3 to 38 %) (Table 12). In real terms the amount of treatment sludge is smaller, because part of sludge is reported twice in VAHTI-database, both treatment plant which generates sludge and the treatment plant which treats that sludge. For example in the year 2009 more real sludge amount is 39 000 tons of sludge. Part of the sludge is reported some plants also receive wastewater sludge from small wastewater treatment plants. In the same year wastewater treatment plants receive septic tank and cesspit sludge waste about 47 700t (dry mass varies from 1 to 20 %). Septic tank and cesspit sludge amount is included in the amount of sludge waste. Also sand waste was produced, but most of the wastewater treatment plants have not reported amount of sand waste. (VAHTI, 2011)

Table 12. Waste from wastewater treatment plants (VAHTI, 2011).

Waste from wastewater treatment					
	EWC-code	**Year 2006 (t)**	**Year 2007 (t)**	**Year 2008 (t)**	**Year 2009 (t)**
Screenings	190801	1023	3756	9169	1280
Sludge from treatment of urban wastewater	190805	51337	55047	43957	47745
Septic tank sludge	200304	45979	52545	50138	50261

Waste from screens and sieves is placed to landfill by all municipal wastewater treatment plants in North Savo (Picture 9).The most common way to handle sludge waste is composting. Only three wastewater treatment plants use other method for sludge handling. In 2009, 73 % of wastewater sludge was composted. Composting methods that is used are conventional composting (compost pile) and drum composting. Other used methods are lime stabilization and digestion. In the year 2009 7 % of wastewater treatment sludge was only stabilized (not any other method was used) and 20 % of wastewater sludge was digested. Couple of wastewater treatment plants only stabilize sludge by lime and use it as soil enrichment. There exists one wastewater treatment plant in North Savo, which digests the sludge (Picture 8). That digestion unit digests also the sludge from two other wastewater treatment plants. Digestion residue is utilized in landscaping. Compost is mainly utilized in landscaping for example in landfill landscaping. The actors who utilize sludge are for example waste management companies and a mining company in Siilinjärvi. (VAHTI, 2011)

It is possible to get a permit for wastewater treatment sludge usage as fertilizer. At this moment there are nine actors in North Savo having Finnish Food Safety Authority Evira's permission to utilize sludge as fertilizers. (Iisalmi, Kiuruvesi, Lapinlahti, Melalahti, Vehmersalmi, Nilsiä, Siilinjärvi, Leppävirta, Varkaus) (Evira, 2010)



Picture 9. Waste treatment of wastewater treatment plants in North Savo in the year 2009.

4.3.3 Waste from agriculture

Manure
Agriculture is the biggest source of biowaste in North Savo. North Savo is the biggest milk production area in Finland and because of that manure amounts are significant. In 2007, manure amount of bovines was about 1,6 million tons in North Savo. At the same year manure produced by pigs, sheep, horses, poultry and goats was about 134.000 tons. Disposal method for cow manure is using as a fertilizer in a field. (Pohjois-Karjalan ympäristökeskus, 2009).

Spoiled feed
About 1,5 % of harvested feed in North Savo is spoiled, which is about 15.000 tons of spoiled feed per year. Farms also have extra feed that they do not need. An amount of extra feed is 1,4 % of feed, which is about 18.300 tons per year. Total amount of spoiled and not used feed is 33.300 tons per year. (Rantala & Viljakainen 2010)

The main disposal method for spoiled feed is utilization as fertilizer. Almost half of the spoiled feed is utilized as fertilizer. About 43 % of spoiled feed is composted and small part of it is for example just carried to the forest without any utilization. (Rantala & Viljakainen 2010)

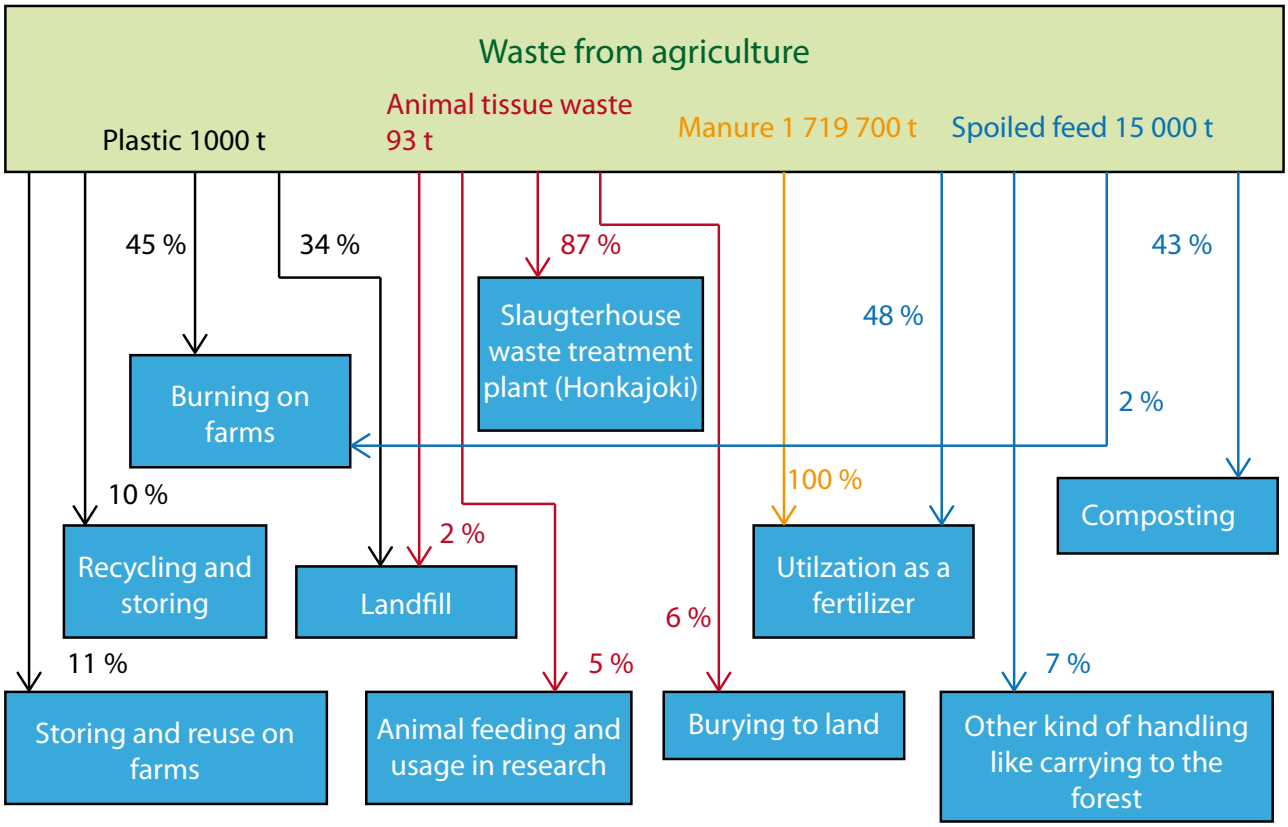
Animal tissue waste
All cows, sheep and goats that have died or have been euthanized in farms have to be delivered to animal waste treatment plant in an area that belongs to animal carcasses collection area. That does not except animals that are stillborn are and out of animal carcasses collection area. North Savo belongs to collection area of death cows, sheep and goat, but is out of pig and poultry carcasses collection area, so pig and poultry carcasses can be buried in ground. Carcasses of cows from North Savo area delivered to Honkajoki Oy, which is an animal waste treatment plant in Western Finland. (VAHTI, 2011)

The average amount of agriculture animal tissue waste in the years 2006-2009 is about 93 tons. This data includes only farms which have an environmental permit. For example when the farm's size is over 30 milk cows, 80 beef cattle, 60 cows or 210 pork pigs is environmental permit needed (YSA 1 § 1 moment 11 section). 87 % of animal tissue waste was handled in slaughter house waste treatment plant (Honkajoki). The most environmental permissible farms in North Savo area are cow farms which explain high percent. Rest of the animal tissue waste is buried in ground, fed for animals or used in research, and a small part is also deposited to landfill. (VAHTI, 2011)

Plastic
Farms in North Savo generate about 1000 tons of plastic waste per year (Pohjois-Karjalan ympäristökeskus, 2009). Plastic waste does not include Municipalities organized obligate waste transportation, so the farms are responsible themselves for taking care of plastic waste to waste treatment. Instead plastic packaging waste is contained in producer responsibility law for packaging waste.

Plastic waste that is produced in agriculture consist mainly of plastic films that are used for storage, covering and fertilizer sacks. According to the results of inquiry study for farmers in North Savo 45 % of plastic waste is burned in farms, even though the waste law permits plastic incineration only in plants which have permission for waste incineration. 34 % of plastic is delivered to landfill and about 10 % of plastic is collected to concentrated place in farms. About half of the plastic that is collected to a concentrated place is further delivered to a plastic waste further treatment for example to Kuusakoski Oy. Rest of the plastic waste is for example stored and reused in farms or buried in ground. (Rantala & Viljakainen, 2010)

The waste streams from agriculture have been illustrated in Picture 10.



Picture 10. Waste amounts and disposal of waste from agriculture.

4.3.4 Waste from industry

Waste from food industry

Waste suitable for energy utilization from food industry consists of waste sludge and material that is unsuitable for consumption or processing (Table 13). In the year 2009 sludge from food industry was treated as follows: 19 % of sludge was disposed to landfill, 26 % was used as material utilization, 46 % was composted and the rest was treated with other methods. Sludge of food industry includes, sludge from washing, cleaning, peeling, centrifuging and separation, edible oil and fat sludge and also sludge-like material that is unsuitable for consumption or processing. (VAHTI, 2011)

Table 13. Waste amounts from food industry (VAHTI, 2011).

Waste from food industry					
	EWC-code	**Year 2006 (t)**	**Year 2007 (t)**	**Year 2008 (t)**	**Year 2009 (t)**
Sludges from on-site effluent treatment	020101	118	65	107	528
Sludges from on-site effluent treatment	020204	72	244	226	195
Sludge from washing, cleaning, peeling, centrifuging and separation	020301	425	450		
Materials unsuitable for consumption or processing	020501	41	38	40	31
Sludge from washing, cleaning, peeling, centrifuging and separation	020502	60	33	56	105
Other kind of sludge	020799	317	367	367	291
Total		**1033**	**1196**	**796**	**1150**

Waste from forestry and wood industry

Wood waste is mainly generated from pulp and paper-, sawmill- and construction industry (Table 14 and Table 16). Wood waste consists of bark, cork and sawdust and is mainly used in energy utilization. Very small part of wood waste (under 1 % in the year 2009) is used for material utilization (for example as a compost supportive material) or disposed to landfill. (VAHTI, 2011)

Sludge from paper and pulp industry is mainly burned, used in forest fertilizing and landscaping or disposed to landfill (Table 15).

Table 14. Waste wood from wood industry (VAHTI, 2011).

Waste wood from wood industry					
	EWC-code	**Year 2006 (t)**	**Year 2007 (t)**	**Year 2008 (t)**	**Year 2009 (t)**
Waste bark & cork	030101	43254	217091	202958	211796
Sawdust, shavings, cuttings, wood, particles board and veneer containing dangerous substances	030104	42477	47973	634	0
Sawdust, shavings, cuttings, wood, particles board and veneer other than those mentioned in 030104	030105	6670	5681	5282	2531
Waste bark & wood	030301	62018	58177	56418	37785
Abrasion wood	030199	6670	5681	5282	2531
Total amount		**161090**	**334603**	**270574**	**254644**

Table 15. Sludge from paper and pulp industry (VAHTI, 2011).

Sludge from paper and pulp industry					
	EWC-code	**Year 2006 (t)**	**Year 2007 (t)**	**Year 2008 (t)**	**Year 2009 (t)**
Sludge from on-site effluent treatment other than those mentioned in 030310	030311	2173	16323	31937	31270

Amounts of constructions wood waste has varied quite much between the years the 2006–2009. Construction wood waste consists mainly of construction wood, wooden bases and stumps (Table 16). Explanation for variation of wood waste amounts per years is yearly changing stump amounts. Because of that construction's wood waste amount for example in 2007 (stumps 11. 900 t) was much higher than in the years 2006, 2008 and 2009. Like other wood waste construction wood waste is mainly utilized in energy production. (VAHTI, 2011)

Table 16. Waste wood from construction industry (VAHTI, 2011).

Waste wood from construction, EWC-code 170201					
	EWC-code	**2006 (t)**	**2007 (t)**	**2008 (t)**	**2009 (t)**
Total amount	**170201**	**5589**	**14579**	**8705**	**6809**

Plastic waste from industry

Separately collected plastic waste consists of waste Electrical and Electronic Equipment (WEEE), construction, municipal and pulp industry plastic waste. Plastic waste in Table 17 includes also municipal plastic waste except plastic packages. All collected plastic waste is mainly utilized in energy production. (VAHTI, 2011)

Table 17. Plastic waste from industry (VAHTI, 2011).

Plastic waste					
	EWC-code	**Year 2006 (t)**	**Year 2007 (t)**	**Year 2008 (t)**	**Year 2009 (t)**
WEEE waste	160214, 160216	8	6	4	2
Construction's plastic waste	170203	5	189	171	100
Municipal plastic waste	200139	316	421	421	117
Plastic waste from pulp industry	030307				14589
Total amount		**329**	**616**	**596**	**14808**

4.3.5 VAHTI-database

The main source of information in gathering waste information of North Savo has been VAHTI-database, which is maintained by Finnish Environment Institute (SYKE). VAHTI contains information on the environmental permits of companies and on their wastes generated, discharges into water and emissions to air. Regional centers for economic development, transport and the environment in Finland use VAHTI-database in their work for preparing and monitoring environmental permits.

4.4 Waste key figures of the region

It is difficult to get regional information about some key figures. Therefore national information is used to calculate some key figures.

In the year 2009 the amount of municipal waste per capita was 478,8 kg/inh. per year in Finland (In the year 2009 municipal waste amount in Finland was 2 562 420 tons and population 5 351 427 inhabitants). (Statistics Finland, 2011; Population register center, 2011)

In the year 2007 the amount of industrial waste per capita in Finland was about 3550 kg/inh. per year (In the year 2007 amount of industrial waste in Finland was 19 000 000 tons). (Statistics Finland, 2011; Population Register Center, 2011)

There was not founded information about the amount of the residues from agriculture in regional or national level.

The potential of bioenergy from waste in North Savo is 1,0 MWh/inh. The waste amount includes manure, crops, sludge and municipal biowaste. (Huopana & Niska, 2011)

5 Energy supply and usage system

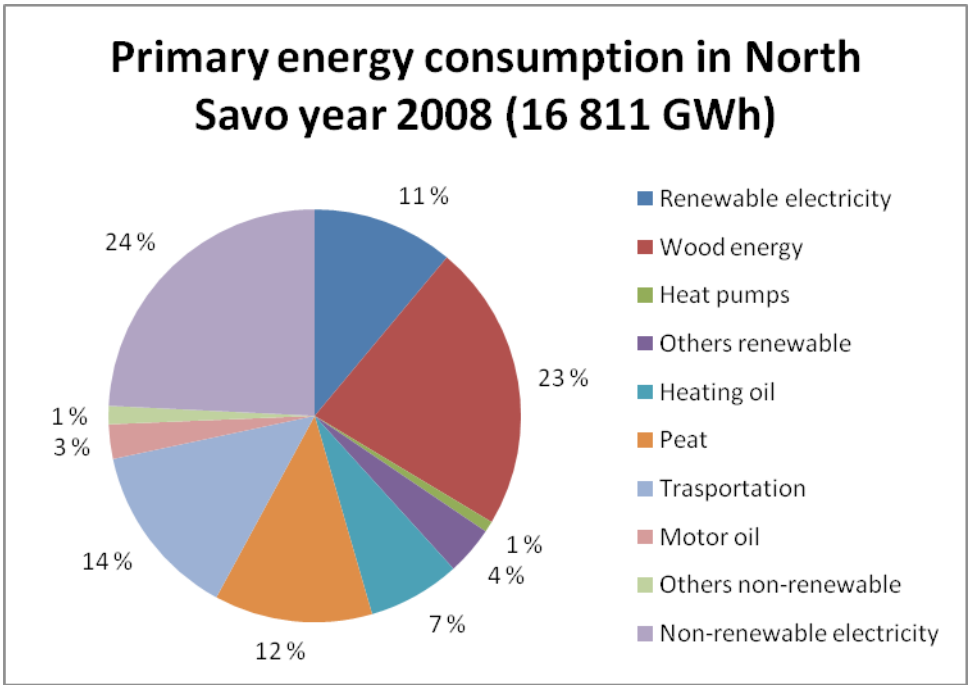
Finland has a target to get 38 % of its energy from renewable sources in the year 2020. In the year 2007 25 % of total energy consumption was renewable energy consumption in Finland. (Motiva Oy, 2011)
The aim of energy management of North Savo is to increase self-sufficiency in heat and electricity production by increasing the use of renewable sources of energy and by improving energy efficiency. The most important resources of energy are wood, field biomass, agriculture and municipal sludge and solid waste. Peat has also an important role in energy recovery because peat production has a significant effect for employment in North Savo. (Pohjois-Karjalan ympäristökeskus, 2009)

5.1 Energy use

Primary energy consumption in North Savo was 16.811 GWh in 2008 from which 38 % was renewable energy consumption (Table 18 and Picture 11). Transportation amounted to 14 % of the total primary energy consumption.

Table 18. Primary energy consumption in North Savo in 2008. (Kajaanin yliopistokeskus, 2010)

Energy	**GWh**
Renewable electricity	1861
Wood energy	3787
Heat pumps	144
Others renewable	640
Heating oil	1218
Peat	2085
Transportation	2310
Motor oil	454
Others non-renewable	240
Non-renewable electricity	4072
Total	**16811**



Picture 11. Primary energy consumption in North Savo in 2008 (Kajaanin yliopistokeskus, 2010)

5.1.1 Electricity

In 2009, electricity consumption in North Savo was 3,700 GWh (Table 19). 30 % of this was consumed by households and agriculture, 20 % by service and buildings and 50 % by industry.

Table 19. Electricity consumption in North Savo in 2009 (Finnish energy industries, 2011b)

Housing and agriculture (GWh)	Service and building (GWh)	Industry (GWh)	Total	Consumers (pc)
1 107	**723**	**1 870**	**3 700**	**151 000**

5.1.2 Heat

Households in North Savo are heated mainly by district heating, electricity, wood, oil and ground heat. In 2009 district heating consumption in North Savo was 1526 MWh and in 2008 1419 MWh according to the statistics of Organization of Finnish Energy Industry (Table 21). Private heating with wood and oil for example is in the same magnitude for consumption as district heating consumption. Industrial heat consumption is about three times as big as district heating consumption and industrial electrical heating about half of that. (Kauppinen, 2010)

5.2 Energy supply

Savon Voima Oyj and Kuopion Energia Oy are the main companies in North Savo which produce electricity and heat. In North Savo Savon Voima Oyj has two combined electricity and heat power plants, one in Iisalmi and one in Kiuruvesi. Moreover, Savon Voima has nine hydro power plants. Altogether Savon Voima Oyj produces electricity approximately 200 GWh per year. (Savon Voima Oyj, 2011)

Kuopion Energia has two power plant units Haapaniemi 1 and Haapaniemi 2 in the same site. The third CHP plant is under construction in the same site in Kuopio. Kuopion Energia produces electricity about 430 GWh per year and district heat about 910 GWh per year. Haapaniemi 2 produces electricity 410 GWh per year and district heat 710 GWh per year. Haapaniemi 1 produces electricity 100 GWh per year and district heat 165 GWh per year. Electricity production of Kuopion Energia provides about 75 % of total electricity demand of Kuopio and about 100 % of district heat demand of Kuopio. (Itä-Suomen ympäristölupavirasto, 2005a)

5.2.1 Electricity

Int the year 2009 electricity was produced 1 043 GWh in North Savo. 7,5 % electricity was produced by hydropower, 87 % by CHP and 5,5 % by separate thermal power. (Finnish energy industries, 2011b)
Remarkable part of electricity supply of North Savo is imported electricity. About two-thirds of electricity is imported electricity (Table 20).

Table 20. Electricity production in North Savo. (Finnish energy industries, 2011b)

GWh	Hydro power	Wind power	Nuclear power	CHP/ industry	CHP / heating	Separate thermal power	Total
	78	0	0	430	479	56	1 043

5.2.2 District heating

District heating in North Savo is generated in four CHP (combined heat and power plant) power plants, in 46 stationary heat plants and in 46 transferable heat plants. Information about district heating production is presented in Table 21.

Main fuels used for district heating production in North Savo are peat, wood and oil. Over half of district heating is produced by peat. Fuel distribution of district heating production is presented in Table 22.

Table 21. District heating network, production capacity and balance in North Savo in 2005-2009. (Finnish energy industries, 2011a)

	DISTRICT HEATING PROCUREMENT		DISTRICT HEATING USE					HEATING POWER PLANTS			FITTED HEATING PLANTS AND PUMPS		MOBILE HEATING PLANTS		TOTAL POWER
	Net production	Purchasing	Consumption	Delivery	Network loss and measuring differences	District heating joint production as a net production	Electric production related district heating production	Number	Total of district heating power	Electric power related district heating production	Number	District heating power	Number	District heating power	Total
	GWh	GWh	GWh	GWh	GWh	GWh	GWh		MW	MW		MW		MW	MW
2009	1 731	317	1 526	317	205	1 207	528	4	320	163	46	690	46	154	1 163
2008	1 385	317	1 419	57	225	988	456	3	260	107	43	643	43	140	1 043
2007	1 611	227	1 439	227	172	1 126	466	4	380	163	38	622	42	137	1 140
2006	1 591	213	1 404	213	187	1 137	473	4	380	163	35	595	36	116	1 091
2005	1 367	188	1 363		192	998	425	3	260	107	35	584	39	119	963

Table 22. Fuel distribution of district heating and joint product electricity in North Savo. (Finnish energy industries, 2011a)

GWh/ year Year	Coal	Heavy fuel oil	Light fuel oil	Milled peat	Sod peat	Forest fuel	Forest residue from industry	Other biomass	Biogas	Mixed fuels	Secondary heat of industry	Electricity	Heat recovered by heating pump	Others	Total fuel amount used in distric heating and joint product elecricity production	Total fuel amount used in distric heating production plants
2009	15	389	6	1 536	41	160	268	102	6	6	61	1	2	71	2 664	617
2008		280	7	1 527	32	109	253		6			1	2		2 217	460
2007	13	305	14	1 643	46	187	190	72	7	11	69	3	2		2 599	568
2006	15	350	12	1 714	47	179	187	104	7	13	60	1	2		2 692	553
2005		393	13	1 389	39	127	195		10			2	1		2 168	437

5.3 Energy balance of North Savo

Energy balance of North Savo is seen in
Table 23 which shows that industry is the biggest electricity and heat consumer in the region. Industry uses over half of produced heat and energy in North Savo.

Table 23. Energy balance of North Savo (Kauppinen, 2010)

LEFT	GWh	RIGHT	GWh
Wood fuels	3 652	Heat consumption	5 470
Black liquor 43 %		Industrial heat	3 410
Natural gas	0	District heat	1 054
Imported electricity	2 897	Private heating	1 005
Hydropower	145	Electric heating	502
Peat	2 087	Electricity consumption	3 912
Oil fuels	1 094	Housing and agriculture	1 072
Recovered fuels	208	Industry	2 131
Coal	243	Service and building	709
Others	1 379	Transportation	947
Gasoline and diesel fuel	2 368	Losses	2 865
Electricity production	1 015	Imported electricity	-2 897
TOTAL	14 073	TOTAL	13 193

BALANCE 880 GWh

5.4 Infrastructure for energy supply

5.4.1 Electricity grids

The electricity grid of Finland is based on the main grid, regional network and distribution network. High voltage electricity is distributed via the main grid, voltage being mainly 400 kV. In the grid, high voltage levels are used when operating with long transmission connections and high transmission capacities in order to minimise losses in electricity transmission. Distribution networks are either connected directly to the main grid or they utilize the grid services through a regional network. Regional network operates at a voltage level of 110 kV and distribution network at voltage level of 0.4 kV to 110 kV. Households are connected to distribution networks. Industries, trade, services and other consumption (such as agriculture) are connected to distribution or regional networks or to the main grid, depending on each individual case. Power plants are connected to distribution or regional networks or to the main grid. (Fingrid Oyj, 2009)

The owner of the main grid is Fingrid Oyj. Distribution network in North Savo is owned by Savon Voima Verkko Oy, Kuopion Energia public utility and Pohjois-Karjalan Sähkö Oy. (Energiamarkkinavirasto, 2011)

5.4.2 District heating

There is 772 km district heating network in North Savo. Kuopion Energia public utility owns 400 km of district

heating network that locates in the city of Kuopio (Kuopion Energia). Savon Voima Oyj supplies district heat in 15 municipalities. Kuopion Energia liikelaitos has 5 056 and Savon Voima 2586 district heating customers in North Savo region. (Finnish energy industries, 2011a) A block of flats, for example, means only one customer from the district heating companies' point of view.

5.4.3 Fuel stations

The main fuel distribution companies in North Savo are Neste Oil, Teboil, ST1, ABC and Shell. These companies distribute mainly fossil fuels. There aren't any biogas, natural gas or bioethanol distribution stations in North Savo. In the fuel stations in Finland, distribution of a new gasoline E10, containing 10 % ethanol, started in the beginning of 2011. This new gasoline replaced the most common gasoline E95, which contained only 5 % of bioethanol. (Uusi Suomi, 2010)

Savon Siemen Oy produces biodiesel in Iisalmi. The capacity is 500.000 litres per year (Savon Siemen Oy, 2011). Savon Siemen Oy has also a biodiesel distribution station in Iisalmi, but it has not been used for couple of years since there has not been enough production for selling biodiesel outside the farm (Sarvela, 2011).

5.4.4 Biogas plants

As mentioned in Chapter 4.2.1, there locate two biogas plants in North Savo area, one in Lehtoniemi wastewater treatment plant of Kuopion Vesi in Kuopio and the other one in Halola Maaninka in the research center of Agrifood Research Finland (MTT). All energy that is produced in the biogas plant of Kuopion Vesi is utilized in waste water treatment plant of Kuopion Vesi (Table 24). Produced energy of the biogas plant of MTT in Maaninka is utilized as heat and electricity in research center of Maaninka (The research center of Agrifood Research Finland, 2009).

Table 24. Kuopion Vesi biogas plant's production in 2006-2009. (Kuittinen et al., 2007-2010)

Year	Biogas production ($1000\ m^3$)	Utilization ($1000\ m^3$)	Electricity ($1000\ m^3$)	Heat (MWh)	CH4 %
2006	1098	1081	2009	4059	66
2007	1081	1059	1942	3914	65
2008	1149	1141	2090	4222	65
2009	1195	1137	2117	4168	65

5.4.5 Hydroelectric power plants

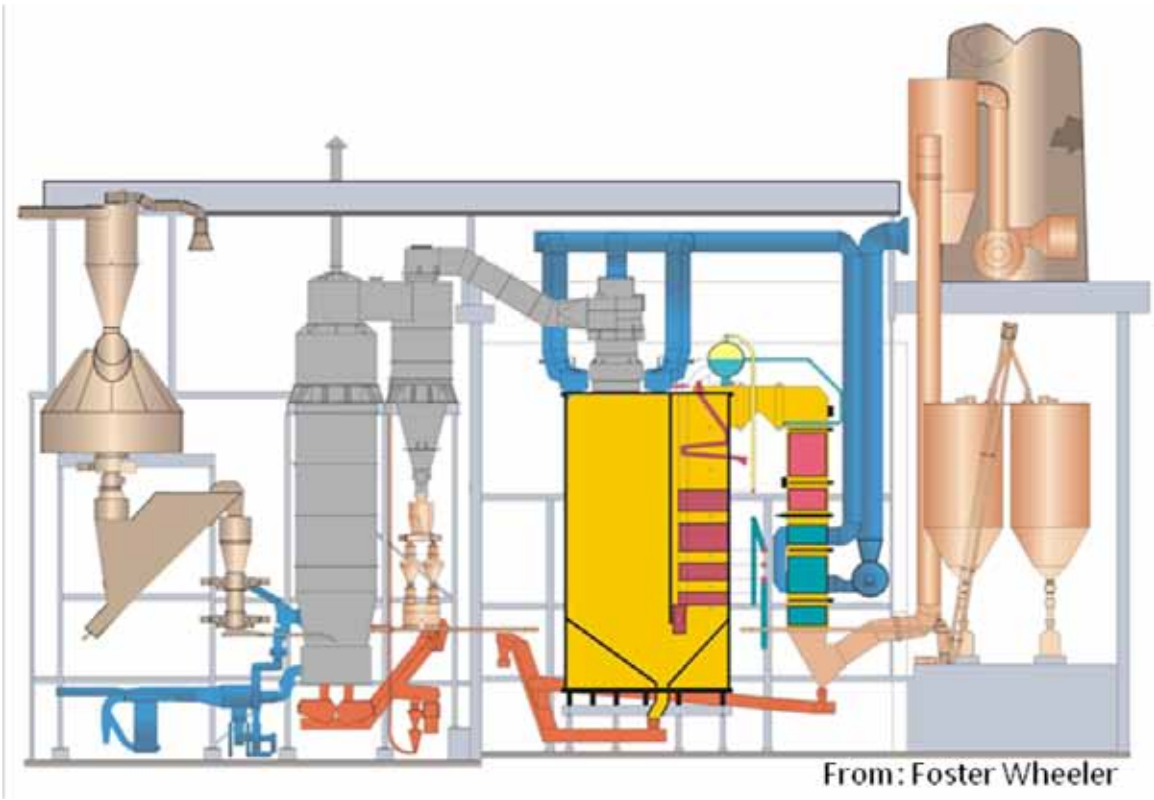
Savon Voima Oy and Stora Enso Oyj own most significant hydroelectric power plants in North Savo. Hydroelectric power plants owned by Savon Voima produce on average 79 GWh energy per year. Stora Enso has the biggest hydroelectric power plant in North Savo, which produces on an average 28 GWh of energy per year. (Ympäristöhallinto, 2011)

5.4.6 Waste gasification plant in Varkaus

There is a waste gasification plant in Varkaus (Picture 12). Before the gasifier was used for gasification of polyethylene plastics/aluminium reject that was from recycled liquid packaging board (Polygeneration in Europe, 2011).

This moment the gasifier is used for experimentation. Stora Enso Oyj has got a permission to experiment gasifier for gasification of REF fuel until the end of the year 2011. Stora Enso has a permission to gasify 2000 tons of fuel. (Itä-Suomen aluehallintovirasto, 2011b)

REF fuel used for gasification is delivered by Ekokem Oy. Ekokem Oy is going to build a waste separation line to Varkaus and is planning to start manufacturing of REF fuel for the gasification plant. The gasification process needs the right kind of fuel and Ekokem has got a permission to experiment fuel quality with help of the gasifier. Material for REF fuel production is waste from industry, trade, building and municipality. (Itä-Suomen aluehallintovirasto, 2011a)



Picture 12. Gasifier in Varkaus. (Polygeneration in Europe, 2011)

5.5 Future goals

As mentioned earlier in Chapter 3.4.3, the Council of State of Finland has made a definition of policy that every municipality has to formulate a climate strategy by 2012, either by itself or in cooperation with other municipalities (Valtioneuvosto 2009 as.143-144). Climate strategy of North Savo is presently under preparation (The Regional Council of North Savo, 2011). Kuopio is one of the municipalities in North Savo which has prepared a climate strategy. Goals of the climate strategy of Kuopio are for instance to decrease greenhouse gas emissions at least 20 % of 1990 level until 2020, increase amount of renewable energy in energy production and decrease greenhouse gas emissions of transportation (Kuopion kaupunki, 2009).

5.6 Energy key figures of the region

It is difficult to get regional information about some key figures. Therefore national information is used to calculate some key figures.

Energy calculation is based on primary energy consumption and supply information.

In the year 2008 primary energy consumption was 67,7 MWh/ inh. In the year 2008 primary energy consumption in North Savo was 16811 GWh and population was 248423 inhabitants. (Population Register Center, 2011; Kajaanin yliopistokeskus, 2010)

In the year 2008 energy supply per inhabitant (In the year 2008 energy supply in North Savo was 6792 GWh) was 27,3 MWh/ inh. (Population Register Center, 2011; Kajaanin yliopistokeskus, 2010)

Energy use per GDP (gross domestic product) 2,4 MWh/GDP. In the year 2008 GDP of North Savo was 7119 milj.€ . (The Regional Council of North Savo, 2011; Kajaanin yliopistokeskus, 2010)

Renewable energy use was 25,9 MWh/ inh. in the year 2008. In the year 2008 renewable energy use was 38,3 % of primary energy use. (Population Register Center, 2011; Kajaanin yliopistokeskus, 2010).

In the year 2008 renewable energy use was 0,9 MWh/GDP. In the year 2008 GDP was 7119 milj.€) (Population Register Center, 2011; Kajaanin yliopistokeskus, 2010).

6 Stakeholders

6.1 Waste management

There is no any single waste-to-energy area focused association or R&D institution in Finland, but several waste management or energy association and institutions operates in the waste- to energy area today in Finland and in North Savo.

6.1.1 Associations

JLY - Finnish Solid Waste Association

The Finnish Solid Waste Association, FSWA (Jätelaitosyhdistys), represents Finnish regional and municipal waste management companies. The member companies take care of the waste management of about 4,9 million citizen (over 90 % of the total population). FSWA is a connecting organization between the member companies, Finnish authorities and European Union. FSWA is a waste management developer in Finland. The main activities of the FSWA are:

- development of legislation and authority regulations of the waste management in Finland and European Union
- initiatives and statements of the topics concerning waste management operations
- research and development in the field of waste management
- publishing and advising in waste management matters
- promoting the exchange of information and experience between members
- organizing exhibitions and training (Finnish Solid Waste Association, 2011)

The FSWA takes an active role in raising the standard of waste management in Finland. The association co-operates actively with the related organizations, the research institutions and the environmental authorities. It advises legislators and policy-makers in questions concerning solid waste management. (Finnish Solid Waste Association, 2011)

Finnish Waste Management Association

Finnish Waste Management Association (Jätehuoltoyhdistys ry) is a professional and ideological joint organization for persons or association working with waste management. Organization contributes knowledge of waste management, relevant waste treatment and waste utilization in Finland and also pursues for wide cooperation with environmental authorities and associations. Finnish Waste Management Association has been founded in the year 1987 by the representatives of state of Finland, municipalities, industry, waste management companies and consults, research and education institutions and civic organizations. The members of the association are persons and communities. (Jätehuoltoyhdistys ry, 2011)

Finnish Biogas association

Finnish Biogas Association (Suomen Biokaasuyhdistys) was founded in the year 1991. It is an association for persons and communities those are interested in contributing of biogas production and use. The purpose of the association is to promote biogas research, product development, production and recovery. The activities of the Finnish Biogas Association are for example:

- to follow the development of biogas field and spread the information about meaning of biogas

- maintain connections for the other association of renewable energy and the interest groups
- organize courses and also discussion and briefing
- operate as an expert in tasks relating to biogas (Suomen biokaasuyhdistys, 2011)

6.1.2 Research and development activities

Research and development activities of an environment and bioenergy technology In North Savo have at a nationwide significant role. Research centers those work in waste to energy sector are University of Eastern Finland (UEF), National Institute for Health and Welfare (THL), Center for Economic Development, Transport and the Environment for North Savo, Savonia University of Applied Sciences, VTT Technical Research Centre of Finland and MTT Agrifood Research Finland. (Pohjois-Savon liitto, 2008)

University of Eastern Finland
Research group of environmental informatics, that is part of the department of Environmental Science of University of Eastern Finland, researches and develops modelling of waste energy utilization and waste transportation.

National Institute for Health and Welfare
The National Institute for Health and Welfare is a research and development institute under the Finnish Ministry of Social Affairs and Health. The Department of Environmental Health of National Institute for Health and Welfare represents international high lever research, which researches exposure to small particles, epidemiology, toxicology and risk assessment. (National Institute for Health and Welfare, 2011)

Centers for economic development, transport and the environment for North Savo
Centers for economic development, transport and the environment for North Savo is a public authority that guides, encourages and monitors the implementation of the Waste Act in the North Savo regions. It also provides training and advices for firms and the public, and issues waste permits to larger firms and operations.

Savonia University of Applied Sciences
Unit of Environmental Engineering, Teaching and Research of Savonia University of Applied Sciences have two focuses, which are water and bioenergy. Bioenergy research focuses on biogas technologies, especially digestion technique of sludge.

VTT Technical Research Centre of Finland
VTT Technical Research Centre of Finland is a globally networked multitechnological contract research organization. VTT provides high-end technology solutions and innovation services. One of VTT's research and technology focus area is energy involving waste into energy, integrated material and energy recovery. One of VTT's offices locates in Kuopio. Kuopio's office is focused on information, communication technology and electronic technologies. (VTT Technical Research Centre of Finland, 2011)

MTT Agrifood Research Finland
MTT Agrifood Research Finland is Finland's leading research institute in the field of agricultural and food research and agricultural environment research. A Research unit of MTT Agrifood Research Finland in Maaninka is focused on biogas technologies of farms. They research and develop biogas solutions of farms in the point of view of energy and material flows with the help of a biogas plant that locates in Maaninka. (MTT Agrifood Research Finland, 2011)

Maito-Savo Center of milk know-how of North Savo
A purpose of Maito-Savo is to develop and strengthen milk cluster in North Savo by increasing knowledge of milk cluster, informing and lobbying of importance of regional economy of milk chain, and also marketing of milk case. Maito-Savo has for example carried out a project that focused on risk assessment and preparation of plan of action of farm's biogas plant. (Maito-Savo, 2011)

6.1.3 Private sector

Waste management and recycling is an important environmental business activity in North Savo. It covers about 10 % of companies' total turnover of environment and bioenergy sector in North Savo. Several companies operate in a waste management and recycling sector. Those companies can be listed for waste treatment, waste transportation, hazardous waste treatment, recycled fuel manufacturing, spoiled land treatment and logistic systems. There operate about twenty waste transportation companies in North Savo. Waste handling companies that operate in the waste- to energy sector are listed earlier in Table 4. (Pohjois-Savon liitto, 2008)

There operate couple other companies also in waste- to energy sector, which are not mentioned in Table 4 like Foster Wheeler Energia Oy, Ecomond Oy, and Crosswrap Oy and also companies that serve sludge technologies. Foster Wheeler Energia Oy develops and delivers efficient, low environmental impact utility and industrial boilers and related services. Circulating fluidized bed technology (CFB) is core competence of the company. Foster Wheeler develops also waste fuel gasification technologies. There operate also several smaller bioenergy boiler manufacturers in North Savo. Ecomond Oy develops and produces logistics management systems for transportation and Crosswrap Oy manufactures waste bale wrapping machines. The companies those serve sludge technologies are: YIT Leppävirta Oy, Scantarp Oy, Suojasauma Oy and Livakka Oy. There operates also couple waste containers and composters manufacturing companies in North Savo. Those companies are: UK-Muovi Oy, Biopallo Systems Oy, Sepa Oy and Adelante Oy. Also several waste branch consultant and designer companies operates in the area. (Pohjois-Savon liitto, 2008)

Also farmers have shown their interests to biogas production from agriculture waste.

6.2 Waste inquiry for companies

During the WP3 work in the REMOWE-project, a waste inquiry was done for various waste producers: companies in electronic and electrical industry, machine and metal industry, chemical industry, food industry, wood processing industry, trade, restaurant and tourist industry and construction industry in North Savo. 33 companies answered for the inquiry concerning waste that is suitable for energy utilization.

In the inquiry was asked how the companies handle biowaste, plastic, paper and board and wood waste. Do they put it to the mixed waste or do they separate the waste in question? The goal of the inquiry was also to make clear the bottle-necks and problems that companies have in the waste-to-energy sector.

On Table 25 it can be seen how much companies put waste suitable for energy utilization to mixed waste. The total number on Table 25 shows the number of answered companies which generate waste in question. Based on the inquiry it can be said that companies put much waste to mixed waste container that would be suitable for energy utilization. That kind of waste is biowaste, plastic, dirty paper and board and also wood (Table 25). Some

reasons for that are:

- no arranged plastic collection
- insufficient waste collection services in countryside (no possibility to separate waste)
- too small space for many waste containers

Table 25. Proportions of various waste fractions suitable for energy utilization among mixed waste in the answered companies.

	0-4 %	5-10 %	11-20%	21-40 %	40-60 %	over 60 %	Total
Plastic	8	8	2	7	2	3	30
Biovaste (for example food waste)	18	7	3	0	2	0	30
Edible oil and fat	28	1	0	0	0	0	29
Dirty paper/board	11	7	4	4	1	3	30
Wood	20	3	0	4	0	2	29

Almost without exception all companies was interested to increase their competitiveness by improving their waste treatment.

7 Conclusions

The County of North Savo is a sparsely populated region with a lot of forest land and water system area. Waste treatment and waste separation works quite well in North Savo compared to many other European countries, but long distances and sparsely populated areas bring challenges for waste management. More challenges to plan waste management come from inadequateness of both waste amount and quality data.

Waste to energy utilization level concerning some waste groups is high, but there is also lot of lost energy because of waste handling method. For example wood waste is mainly used for energy utilization, but municipal biowaste is composted.

There is a lot of potential biowaste in North Savo area that could be used for biogas production. At this moment biowaste like waste water sludge (about 48 000 tons) and municipal biowaste (about 7 000 tons) is mainly composted and the energy content of the waste is lost. North Savo is a significant animal husbandry area in Finland and because of that a lot of manure (about 134 000 tons) is generated in the area. Nowadays manure is mainly used for soil fertilizing without any waste treatment method. It would be more feasible to digest manure and utilize its energy content. Moreover, digestion residue of manure is still good or even better soil fertilizer after digestion than untreated manure and at the same time smell problems decrease remarkably.

Table 26 presents the summary of the waste energy utilization and its development possibilities over the North Savo region. Currently the energy utilization is realized only in the couple of the cases.

Table 26. Current energy utilization of municipal waste and its development possibilities in the North Savo region. Cell having a green background indicates that the energy utilization is realized, and a white background indicates that the energy utilization needs development.

Region of waste management company in North Savo	Waste disposal method of biowaste	Biogas collection from landfill / biogas treatment method	Separate collection of burnable municipal waste	Possibility for burnable waste preprocessing/ sorting	Amount of digestion plants
Ylä-Savon jätehuolto Oy	Cell digestion/ burning in a torch	Yes/ burning in a torch	Yes by private waste treatment center	In a private waste treatment center	0
Jätekukko Oy	Composting in Outokumpu	Yes /burning in a district heating plant	No	In a waste center of Jätekukko Oy	1
Keski-Savon jätehuolto	Composting	Yes/ oxidizing by biofilter	No	No	0

High investment prices of plant investments and small waste amounts are reasons which have delayed waste plant investments in the area. Also unclear demand for produced energy (especially heat) in the region has an influence on that.

Waste energy utilization has decreased in North Savo after the waste co-combustion regulations tightened in 1.1.2006. This has especially decreased utilization of plastics. At this moment several actors are defining possibilities to build a waste incineration plant to North Savo. If a waste incineration plant would be invested in the area it would mean a clear boost in waste to energy utilization in North Savo area and other surrounding regions.

Companies in North Savo have interest to increase their competitiveness by improving waste to energy utilization

and thus reduce the cost for waste handling. By far, however, it has been too cheap to put waste to mixed waste instead of more separating the waste streams. Waste producers in North Savo hope that a waste incineration possibility would realize in Eastern part of Finland. As there are so many operators in the field and the needed investments are big, it needs lots of versatile co-operation to get things forward.

References

CO2-raportti (2011). http://www.co2-raportti.fi/ [Last visited 2012/3/22]

Energiamarkkinavirasto (2011). http://www.energiamarkkinavirasto.fi/ [Last visited 2011/2/17]

Evira (2010). Lannoitevalmitelain 29§ mukaiseen rekisteriin merkityt toimijat. Evira, Valvontaosasto, Maatouskemianyksikkö 18.8.2010.

Fingrid Oyj (2009). http://www.fingrid.fi/portal/in_english/ [Last visited 2011/2/2]

Finland's environmental administration (2011). http://www.ymparisto.fi/default.asp?node=4032&lan=en/ [Last visited 2011/3/10]

Finnish energy industries (2011a). District heating statistics.

Finnish energy industries (2011b). Electricity statistics.

Finnish Meteorological Institute (2010). http://en.ilmatieteenlaitos.fi/climate/ [Last visited 2010/12/2]

Finnish Solid Waste Association (2011). http://www.jly.fi/jly0_eng.php?treeviewid=tree1_eng&nodeid=0/ [Last visited 2011/5/19]

Grönlund Anne (2011). Center for Economic Development, Transport and the Environment for North Savo.

Huopana & Niska (2011). Regional model for biogas production. Draft version. University of Eastern Finland.

Huttunen Leena, Jätekukko Oy (2011). E-mail to Ossi Tukiainen 4.1.2011.

Ilmasto.org (2011). Several writers. Kaikki ilmaston muutoksesta. http://www.ilmasto.org/lisatietoa/ ilmastosivuista.html/

Itä-Suomen aluehallintovirasto (2011a). Päätös nro 11/2011/1. Dnro ISAVI/262/04.08/2010.

Itä-Suomen aluehallintovirasto (2011b). Päätös nro 23/2011/1. Dnro ISAVI/278/04.08/2010.

Itä-Suomen maakuntien liitot (2008). Itä-Suomen bioenergiaohjelma 2015.

Itä-Suomen ympäristölupavirasto (2006). Lapinlahden jätevedenpuhdistamon lietteen termisen kuivauksen ja biolämpövoima-laitoksen ympäristölupa ja toiminnan aloittamislupa, Lapinlahti. Päätös Nro 39/06/2. Dnro ISY-2005-Y-211.

Itä-Suomen ympäristölupavirasto (2005a). Kuopion Energian Haapaniemen voimalaitoksen ympäristölupahakemus. Dnro PSA-2005-Y121.

Itä-Suomen ympäristölupavirasto (2005b). Suonenjoen kaupungin jätevedenpuhdistamon ja kompostointitoiminnan ympäristölupa. Päätös Nro 121/05/2. Dnro ISY-2004-Y-120.

Itä-Suomen ympäristölupavirasto (2003). Siilinjärven jätevedenpuhdistamoa ja kompostointilaitosta koskeva

ympäristölupapäätös. Päätös Nro 121/05/2. Dnro ISY-2004-Y-120.

Jätehuoltoyhdistys ry (2011). http://www.jatehuoltoyhdistys.fi/ [Last visited 2011/5/23]

Jätekukko Oy (2009). Jätekukko Oy:n vuosikertomus 2009.

Jätekukko Oy (2011). http://www.jatekukko.fi/www/fi/index.php [Last visited 2011/2/2]

Jätekukko Oy:n toimialueen kunnat (2010). Jätekukko Oy:n osakaskuntien jätepoliittinen ohjelma vuoteen 2015. Ohjelmaluonnos 13.10.2010. http://www.jatekukko.fi/www/fi/liitetiedostot/ohjeet_esitteet/raportit/Jaetestrategia_koko.pdf

Jätelaitosyhdistys (2011). http://www.jly.fi/index.php/ [Last visited 2011/4/18]

Kajaanin yliopistokeskus (2010). Itä-Suomen energiatilastointi 20.4.2010 luonnos.

Kauhanen Risto, Ylä-Savon jätehuolto (2010). Discussion with Risto Kauhanen 2011.

Kauppinen Tiina (2010). Energy Balance of North Savonia in 2008. Thesis of Master's degree programme in Industrial Management. Savonia university of applied sciences, in business and engineering, Varkaus.

Keski-Savon Jätehuolto (2011). http://www.keskisavonjatehuolto.fi/ [Last visited 2011/3/3]

Kuittinen Ville, Huttunen Markku J. & Leinonen Simo (2010). Suomen biokaasulaitosrekisteri n:o 13. Tiedot vuodelta 2009.

Kuittinen Ville, Huttunen Markku J. & Leinonen Simo (2009). Suomen biokaasulaitosrekisteri n:o 12. Tiedot vuodelta 2008.

Kuittinen Ville, Huttunen Markku J. & Leinonen Simo (2008). Suomen biokaasulaitosrekisteri n:o 11. Tiedot vuodelta 2007.

Kuittinen Ville, Huttunen Markku J. & Leinonen Simo (2007). Suomen biokaasulaitosrekisteri n:o 10. Tiedot vuodelta 2006.

Kuopion Energia. Kaukolämpöesite. http://www.kuopionenergia.fi/filebank/373-kaukolampoesitefinal.pdf/

Kuopion Energian Haapaniemen voimalaitoksen ympäristölupahakemus (2007). Dnro. PSA-2005-Y-91-121.

Kuopion kaupunki (2009). Kuopion ilmastopoliittinen ohjelma 2009 – 2020. Tavoite- ja kehittämissuunnitelmat.

Lind Juha, Vapo Oy (2010). Discussion with Juha Lind in Varkaus 2010.

Maito-Savo (2011) http://aluekehityssaatio.fi/maitosavo/ [Last visited 2011/5/19]

Motiva Oy (2011). http://www.motiva.fi/motiva_oy/ [Last visited 2011/1/10]

National Institute for Health and Welfare (2011). http://www.thl.fi/en_US/web/en/ [Last visited 2011/5/23]

Pohjois-Karjala, Kainuu, Pohjois-Savo, Etelä-Savo ja Etelä-Karjala (2011). Itä-Suomi uusiutuu. Itä-Suomen

bioenergiaohjelma 2020. ISBEO 2020. Luonnos 28.4.2011

Pohjois-Karjalan ympäristökeskus (2009). Itä-Suomen jätesuunnitelma vuoteen 2016. Etelä-Savon ympäristökeskus, Pohjois-Savon ympäristökeskus ja Pohjois-Karjalan ympäristökeskus. Suomen ympäristö 47/2009.

Pohjois-Savon Elinkeino-, liikenne ja ympäristökeskus (2010). Pohjois-Savon vesienhoidon toimenpideohjelma vuosille 2010 - 2015.

The Regional Council of North Savo (2011). http://www.pohjois-savo.fi/ [Last visited 2011/4/5]

Pohjois-Savon liitto (2010a). Pohjois-Savon maakuntakaava 2030. Maakuntakaavaselostus. Pohjois-Savon liiton julkaisu A:67. Kuopio 2010.

Pohjois-Savon liitto (2010b). Pohjois-Savon maakuntaohjelma 2011 – 2014. Pohjois-Savon liiton julkaisu B:74.

Pohjois-Savon liitto (2008). Energia ja ympäristöteknologia teemaohjelma. Pohjois-Savon liiton julkaisu A55. Kuopio 2008.

Polygeneration in Europe (2011). http://www.polygeneration.org/cms/front_content.php/ [Last visited 15.4.2011]

Population register center (2011). http://www.vaestorekisterikeskus.fi/ [Last visited 2011/4/27]

Rantala Teija & Viljakainen Anna-Liisa, 2010. Esiselvitys maa- ja hevostalouden sivutuotteiden hyödyntämismahdollisuuksista Pohjois-Savossa (Nurmirehu, maatalousmuovit, hevosenlanta, olki). Epäkurantin nurmirehun ja hevosenlannan hyödyntäminen energiana –hankkeen loppuraportti.

Sarvela Antti, Savon Siemen Oy (2011). E-mail to Ari Jääskeläinen 25.3.2011.

Savon Siemen Oy (2011). http://www.savonsiemen.com/ [Last visited 2011/2/2]

Savon Voima Oyj (2011). Home pages. http://www.savonvoima.fi/Yritysesittely/energian_tuotanto/Sivut/energian_tuotanto.aspx/ [Last visited 2011/3/28]

Savon yrittäjät (2011). Pk-yritysbarometri kevät 2011-raportti. http://www.yrittajat.fi/File/7c4034d1-a837-41c9-b036-536950be287f/SY_pkbarometri_kevat_2011.pdf/

Simola Antti & Kola Jukka (toim.) (2010). Bioenergian tuotannon aluetaloudelliset vaikutukset Suomessa – BioReg-hankkeen loppuraportti. Julkaisu Nro 49. Taloustieteen laitos, Helsingin yliopisto.

Statistics Finland (2011). http://www.tilastokeskus.fi/ [Last visited 2011/4/27]

Suomen biokaasuyhdistys (2011). http://www.biokaasuyhdistys.net/index.php?option=com_content&view=frontpage&Itemid=1/ [Last visited 2011/5/23]

The research center of Agrifood Research Finland (2009). https://portal.mtt.fi/portal/page/portal/mtt/mtt/tutkimus/infrastruktuuri/maaningantutkimusalusta/ [Last visited 2011/3/23].

The Regional Council of North Savo (2011a). http://www.pohjois-savo.fi/en/psl/ [Last visited 2011/3/3]

Tilastokeskus (2011). http://tilastokeskus.fi/til/vaenn/2004/vaenn_2004_2004-09-20_tau_002.html/ [Last visited 2011/2/10]

Ulkoasiainministeriö (2011). http://www.eurooppatiedotus.fi/Public/default.aspx/ [Last visited 2011/3/3]

Uusi Suomi (2010). Hyvästi E95, nyt tulee E10. Article on 21.12.2010. http://www.uusisuomi.fi/ymparisto/107654-hyvasti-e95-nyt-tulee-e10/ [Last visited 2011/3/25]

VAHTI, The Finnish environmental data systems. Finnish Environment Institute. [Last visited 2011/3/17].

VTT Technical Research Centre of Finland (2011). http://www.vtt.fi/?lang=en/ [Last visited 2011/5/19]

Ylä-Savon jätehuolto Oy (2011). http://www.ylasavonjatehuolto.fi/ [Last visited 2011/2/2]

Ympäristöministeriö (2010). Biohajoavista jätteistä enemmän energiaa. Biojäte-energiatyöryhmän raportti. Ympäristöministeriön raportteja 3/2010.

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Julkaisun nimi
Current status of the waste-to-energy chain in the County of North Savo, Finland

Tiivistelmä
Tässä raportissa esitetään jätteiden energiakäytön nykytilaa Pohjois-Savossa. Raportti on osa laajempaa REMOWE–Regional Mobilizing of Sustainable Waste-to-Energy Production –hankekokonaisuutta, johon on saatu rahoitus EU:n Itämeriohjelmasta. Projektissa mukana olevat muut alueet ovat samalla tavalla selvittäneet jätehuollon nykytilaa, jätteiden energiakäytön mahdollisuuksia ja kehitystarpeita. Tavoitteena on edistää jätteen energiakäyttöön liittyvien hyvien käytäntöjen, strategioiden ja prosessien siirtämistä Itämeren eri alueiden välillä.
Raportin yhteydessä on koottu tietoja Pohjois-Savon jätehuollosta, joita voidaan hyödyntää Remowe-projektin muissa osa-alueissa. Eräs tärkeimmistä on mallin kehittäminen, jolla voidaan arvioida tulevaisuuden mahdollisuuksia jätteiden energiakäytössä.
Raportissa esitetään mm:
- jätehuollon nykytila (syntypaikkoja, määriä ja jätevirtoja)
- energiantuotannon nykytilaa (energian käyttö, tuotanto)
- lainsäädäntö ja hallinto
- toiminnanharjoittajia ja yrityksiä jotka toimivat jätteiden energiakäytön parissa
Nykytilan tietoja esitetään vuosilta 2006-2009.
• Vuonna 2009 sekalaisen jätteen määrä on arviolta 479 kg/ asukas Suomessa. Teollisuusjätteen määrä on vastaavasti 3550 kg/asukas. Biohajoavan jätteen sisältämäksi energiapotentiaaliksi Pohjois-Savossa on arvioitu 1 MWh/asukas. Tähän lukuun sisältyy maatalouden lanta ja korsi soveltuvin osin, jätevesilietteet ja erikseen kerätty biojäte.
• Pohjois-Savossa toimii kaksi biokaasua tuottavaa mädättämöä, toinen Kuopion Veden Lehtoniemen jätevesilietteen mädättämö ja toinen on Maatalouden tutkimuskeskuksen maatilamittakaavan laitos Maaningan tutkimusasemalla. Lisäksi biokaasua kerätään Kuopiossa talteen Heinälamminrinteen kaatopaikalta ja suljetulta Silmäsuon kaatopaikalta käytettäväksi aluelämpölaitoksessa.
• Tällä hetkellä Pohjois-Savon alueella ei ole jätteen energiahyötykäyttöä. Jätekukko Oy valmistaa esikäsiteltyä polttokelpoista jätettä, jota hyödynnetään Etelä-Suomen polttolaitoksissa. Varkauteen on suunnitteilla yhteinen jätteenpolttolaitos.

Asiasanat
jäte, jätteen energiakäyttö, jätteenpoltto, Pohjois-Savo, biokaasu

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Current status of the waste-to-energy chain in the County of North Savo, Finland

Abstract

The aim of this report is to describe the current status of the waste-to-energy chain in the province of Northern Savonia in Finland. This work is part of the Baltic Sea Region Programme project Remowe-Regional Mobilizing of Sustainable Waste-to-Energy Production (2009-2012). Partnering regions across Baltic Sea countries have parallelly investigated the current status, bottle-necks and needs for development in their regions.
Information about the current status is crucial for the further work within the Remowe project, e.g. in investigating the possible future status in target regions. Ultimate result from the Northern Savonia point of view will be a regional model which utilizes all available information and facilitates decision-making concerning energy utilization of waste.
The report contains information on among others:

- waste management system (sources, amounts, infrastructure)
- energy system (use, supply, infrastructure)
- administrative structure and legislation
- actors and stakeholders in the waste-to-energy field, including interest and development ideas

The current status of the regions will be compared in a separate Remowe report, with the focus on finding best practices that could be transferred among the regions.
In this report, the current status has been defined as 2006-2009.
In 2009, the municipal waste amount per capita was 479 kg/inhabitant in Finland. Industrial waste amounted 3550 kg/inhabitant, respectively. The potential bioenergy from biodegradable waste amounts 1 MWh/inhabitant in Northern Savonia. This figure includes animal manure, crops that would be suitable for energy use, sludge from municipal sewage treatment plants and separately collected biowaste. A key strategy influencing also to Remowe work is the waste plan for Eastern Finland.
Currently there operate two digestion plants in Northern Savonia: Lehtoniemi municipal sewage treatment sludge digestion plant of Kuopion Vesi and the farm-scale research biogas plant of Agrifood Research Finland in Maaninka. Moreover, landfill gas is collected to energy use from Heinälamminrinne waste management centre and Silmäsuo closed landfill site, both belonging to Jätekukko Oy.
Currently there is no thermal utilization of waste in Northern Savonia region. However, Jätekukko Oy is pretreating mixed waste and delivering refuse derived fuel (RDF) to Southern Finland to combustion. There is a strong willingness among seven regional waste management companies in Eastern Finland to build a waste incineration plant to Riikinneva waste management centre near city of Varkaus. The plant would use circulating fluidized bed (CFB) boiler. This would been a clear boost in waste-to-energy utilization in Northern Savonia and in many surrounding regions.

Keywords

waste, waste-to-energy, Northern Savonia, biogas, waste incineration

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REMOWE –kyselylomake energiahyötykäyttöön sopivista jätteistä

Yrityksen yhteystiedot:

Yrityksen nimi:
Yrityksen osoite:
Yhteyshenkilö:
Puhelinnumero: Sähköpostiosoite: Kotisivun osoite:
Toimiala:
Työntekijöiden määrä:

Tällä kyselyllä kartoitamme Pohjois-Savossa syntyviä jätevirtoja, jotka voitaisiin hyödyntää energiahyötykäytössä. Lisäksi kyselyllä kerätään uusia ideoita jätteiden energiahyötykäytöstä sekä selvitetään energiahyötykäytön tämän hetkisiä pullonkauloja. Jätteen energiahyötykäyttöön sopivia jätejakeita ovat biohajoavat jätteet (kuten elintarvikejäte ja paistorasvat), joita voidaan hyödyntää esimerkiksi biokaasuntuotannossa sekä polttokelpoiset jätteet (kuten puu, muovi, paperi ja pahvi).

1. Energiahyötykäyttöön sopivat jätteet

Energiahyötykäyttöön sopivia jätteitä ovat esimerkiksi: biojäte, pahvi, paperi, puuperäinen jäte sekä muovi. Millaista energiahyötykäyttöön sopivaa jätettä yrityksessänne syntyy? Olemme kiinnostuneita sekajätteen sisältämästä energiahyötykäyttöön sopivasta jätejakeesta, erilliskerätystä biojätteestä ja puujätteestä. Tällä hetkellä energiahyötykäyttöön sopivan sekajätteen lajittelu on vapaaehtoisuuteen perustuvaa ja vain harva jätehuoltoyritys tarjoaa energiajätteen erilliskeräysmahdollisuutta.

SEKAJÄTE

Keräysastian koko
Vaihtoehdot: 140 litraa, 240 litraa, 360 litraa, 660 litraa, vaihtolava 12 m^3, vaihtolava 16 m^3 vaihtolava 20 m^3, puristin 10 m^3, puristin 15 m^3, puristin 20m^3

Keräysastioiden määrä
Vaihtoehdot: 1, 2, 3, 4, 5, 6, yli 6

Keräysastioiden tyhjennysväli
Vaihtoehdot: 1 viikko, 2 viikkoa, 3 viikkoa, 4 viikkoa, yli 4 viikkoa

Kuinka paljon sekajäte sisältää seuraavia energiahyötykäyttöön sopivia jätejakeita?

a) muovijäte **b) biojäte (esim. ruuantähteet)**
c) öljy ja rasva (kasvi/eläinperäinen) **d) likainen pahvi/paperi** **e) puu**
Vaihtoehdot: ei merkittävästi, 5-10 %, 11 – 20 %, 21 – 40 %, 40 – 60 %, yli 60 %

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ERILLISKERÄTTY BIOJÄTE

Mistä erilliskerätty biojäte sisältää?
Avoin kenttä

Jätteen koostumus
Vaihtoehdot: neste, liete, kiinteä

Keräysastian koko
Vaihtoehdot: 140 litraa, 240 litraa, 360 litraa, 660 litraa, puristin 10 m^3, puristin 15 m^3

Keräysastioiden määrä
Vaihtoehdot: 1, 2, 3, 4, 5, 6, yli 6

Keräysastioiden tyhjennysväli
Vaihtoehdot: 3 krt/viikko, 2 krt/viikko, 1 viikko, 2 viikkoa, 3 viikkoa, 4 viikkoa, yli 4 viikkoa

Jätteen käsittely
Vaihtoehdot: kompostointi, syöttäminen eläimille, maahan hautaaminen, pellolle/metsään vieminen, maan/metsän lannoitteena hyödyntäminen, raaka-aineena hyödyntäminen, muu mikä? (avoin kohta)

Jos valitsit jätteenkäsittelyvaihtoehdoksi jokin muu mikä, kerro siitä tarkemmin.

Jätteen käsittelijä
Vaihtoehdot: omatoiminen käsittely, jätehuoltoyritys, jokin muu taho

Jos valitsit jätteenkäsittelijäksi jokin muu taho, kerro siitä tarkemmin.

ERILLISKERÄTTY PUUJÄTE

Mistä erilliskerätty puujäte koostuu?
Avoin kenttä

Puujätteen laatu
Vaihtoehdot: Käsittelemätön puu, käsitelty puu

Puujätejakeen koko
Vaihtoehdot: Puru, hake, lauta (alle metri), pitkä puutavara (yli metri), levy, sekalainen

Vaihtolavan koko:

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Vaihtoehdot: 12 m^3, 14 m^3, 16 m^3, 18 m^3, 20 m^3

Keräysastioiden määrä:
Vaihtoehdot: 1, 2, 3, 4, 5, 6, yli 6

Keräysastioiden tyhjennysväli:
Vaihtoehdot: 1 viikko, 2 viikkoa, 3 viikkoa, 4 viikkoa, yli 4 viikkoa

Jätteen käsittely
Vaihtoehdot: energiahyödyntäminen, kompostin tukiaineena hyödyntäminen, muu materiaalihyödyntäminen, muu mikä? (avoin kohta)

Jos valitsit jätteenkäsittelyvaihtoehdoksi jokin muu mikä, kerro siitä tarkemmin.

Jätteen käsittelijä
Vaihtoehdot: omatoiminen käsittely, jätehuoltoyritys, jokin muu taho

Jos valitsit jätteenkäsittelyvaihtoehdoksi jokin muu taho, kerro siitä tarkemmin.

JOKIN MUU ENERGIAHYÖTYKÄYTTÄÄN SOPIVA JÄTE

Mikä jätejae on kyseessä?
Avoin kenttä

Mitä jätejae sisältää?
Avoin kenttä

Jätteen koostumus
Vaihtoehdot: neste, liete, kiinteä

Keräysastian koko
Vaihtoehdot: 140 litraa, 240 litraa, 360 litraa, 660 litraa, puristin, vaihtolava

Keräysastioiden määrä
Vaihtoehdot: 1, 2, 3, 4, 5, 6, yli 6

Keräysastioiden tyhjennysväli
Vaihtoehdot: 1 viikko, 2 viikkoa, 3 viikkoa, 4 viikkoa, yli 4 viikkoa

Jätteen käsittely
Vaihtoehdot: kompostointi, syöttäminen eläimille, maahan hautaaminen, pellolle/metsään vieminen, maan/metsän lannoitteena hyödyntäminen, energiahyödyntäminen, kompostin tukiaineena hyödyntäminen, muu materiaalihyödyntäminen, muu mikä? (avoin kohta)

Jos valitsit jätteenkäsittelyvaihtoehdoksi jokin muu mikä, kerro siitä tarkemmin.

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Jätteen käsittelijä
Vaihtoehdot: omatoiminen käsittely, jätehuoltoyritys, jokin muu taho

Jos valitsit jätteenkäsittelijäksi jokin muu taho, kerro siitä tarkemmin.

2. Ongelmakohdat ja kehittämisideat

a) Onko teillä ideoita, kuinka yrityksessänne syntyviä jätteitä voitaisiin hyödyntää energiahyötykäytössä? Kertokaa niistä tarkemmin.

b) Oletteko törmänneet ongelmiin, joiden vuoksi jätteiden energiahyötykäyttö on hankalaa tai ei ole käytännössä mahdollista? Kertokaa niistä tarkemmin.

3. Jäteosaamisen kehittäminen

a) Koetteko kaipaavanne lisäopastusta ja tukea yrityksenne jätteidenkäsittelyssä? Kertokaa tarkemmin.

b) Olisitteko kiinnostuneita parantamaan yrityksenne kilpailukykyä jätehuoltoanne parantamalla?

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remowe
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